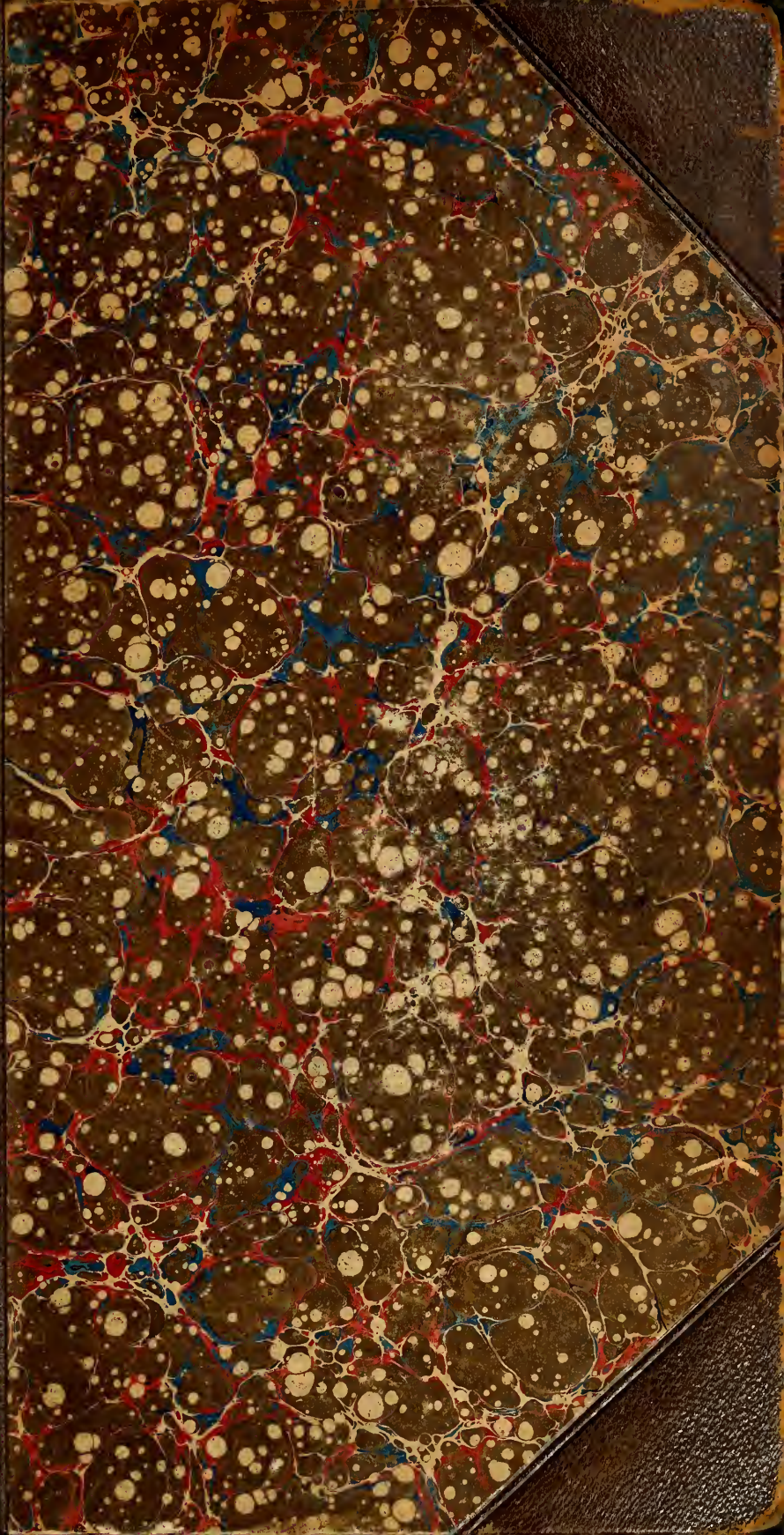

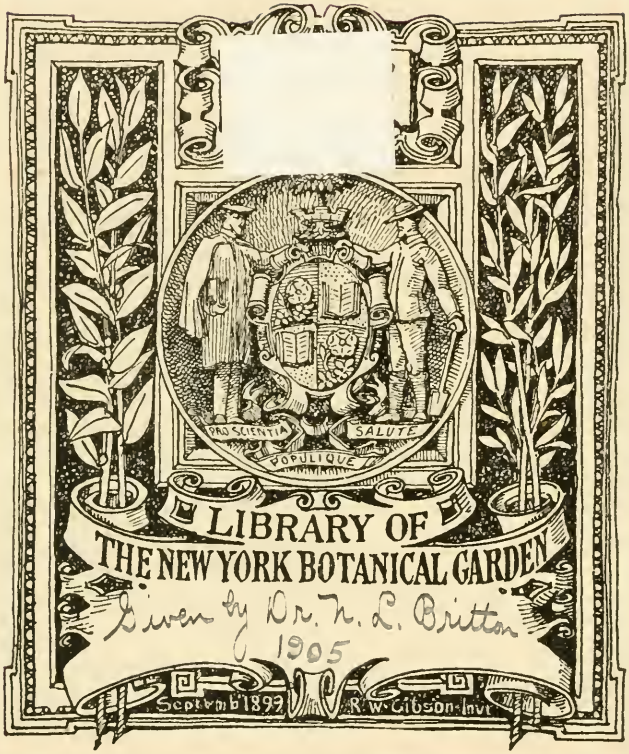
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TRANSACTIONS

OF THE

NEW YORK ACADEMY OF SCIENCES.

October 3, 1881.

REGULAR BUSINESS MEETING.

Vice-President, Dr. B. N. MARTIN, in the chair.

Twenty-five members present.

After the transaction of business the members were invited, in accordance with the usual custom at the first meeting of the season, to present notes and observations recorded during the summer, and responses were made by Mrs. E. A. SMITH, Prof. C. A. SEELEY, and others.

Mr. W. L. CHAMBERLAIN referred to the gold deposits recently opened in Fulton and Saratoga counties, N. Y. The ore consists of auriferous pyrites and is contained in the gneiss of the foothills of the Adirondacks.

Remarks were made by a member, on a visit to the sandstone quarries at Portland, Conn.; by Mr. TODD, on a peculiar atmospheric phenomenon, a vaporous band stretching across the sky, apparently not auroral, observed in the Adirondacks; and by Dr. MARTIN, on a remarkable atmospheric coloration, luminous brilliance of the clouds, etc., observed last month at Saratoga, in the early morning, attributing it to an abundance of a smoky fog produced by the recent forest fires, and calling attention to the fact that this phenomenon has been noticed only in the territory east of the meridian of Saratoga.

Mrs. P. HANAFORD described the same appearances as seen during the "Yellow Day," Sept. 6, near Boston, and also on Nantucket; another member, as seen in the Genesee valley, explaining that the strong west and northwest winds prevailing at the time had wafted high in the air vast volumes of smoke derived from the abundant forest fires throughout Western N. Y.; Messrs. TODD, CHAMBERLAIN, and others, describing the electric brilliance of the gas-lights, the strange modification of the green color of foliage, the absence of smoky odor, etc., as observed at Great Barrington, Mass., and in less degree in New York city; Mr. N. L. BRITTON, on the same facts as observed several

miles out at sea, off Fire Island and Montauk Point, Long Island, N. Y.; Prof. D. S. MARTIN, as observed between Saratoga and Catskill, N. Y.; and Prof. C. A. SEELEY, calling attention to the extremely attenuated character of the carbon particles, produced by their long transportation from distant localities.

Mr. GEO. F. KUNZ mentioned that Mt. Mica, at Paris, Maine, the locality so famous for colored tourmalines for the last fifty years, had been purchased by a mining company and was being worked for cassiterite, mica and tourmaline, principally through the efforts of Dr. A. C. Hamlin of Bangor, Maine.

Dr. Hamlin has the finest known collection of American tourmalines, and he recently reported the discovery of a crystal three inches long and one-half inch thick, a transparent gem of a beautiful blue-green color. This was taken from the new mine, and many more remarkable specimens may be expected as the work advances.

Mr. Kunz said that during the last year a German agate-hunter returned to his native country after 20 years collecting in Brazil, taking with him a large suite of fine colored tourmalines, some five inches long and not more than one-eighth of an inch thick, transparent, and of a green color; also many fine green crystals with red, yellow, white, and other colored centres, many of these equalling for variety of color anything yet found, most of which will cut as gems. There is also in this lot one exceptionally fine green crystal over one inch square. This collector brought with him also at least 1000 kilos of transparent yellow spodumene, the same as that described by A. Pisani, of Paris, some eighteen months ago, and is dissimilar only in color to the new variety of spodumene found at Stony Point, North Carolina, described in the February number of the *American Journal of Science* for 1881, by Dr. J. Lawrence Smith, as Hiddenite. Some of the specimens which he brought will cut as fine yellow gems. All these were found in the Minas Geraes district. Recently a new locality for chrysoberyls has been found in Ceylon, where they occur of gem value in an unusual variety of colors, from yellow to brown, and from brown to green. The last color is the variety known as Alexandrite. This gem has heretofore been found but of very inferior size and color, but here it occurs of remarkable size, having in one case afforded a gem weighing 26 kts. They are a beautiful green color by day and a columbine red, or brownish red, by night. The chrysoberyl cat's eye is found here of the same color, and possessing the same dichroic property as the Alexandrite, viz., changing color, from green to red, and hence might very properly be called an Alexandrite cat's eye. Many of the chrysoberyls are erroneously called and sold as a variety of sapphire.

October 10, 1881.

SECTION OF CHEMISTRY.

Vice-president, Dr. B. N. MARTIN, in the Chair.

Nineteen members present.

A paper was read by Mr. JAMES H. STEBBINS, Jr., of which the following is an abstract:

ON SOME NEW SALTS OF THYMOLE SULPHO-ACID, AND SOME NEW FACTS CONCERNING THE SAME.

60 grms. thymole were dissolved in 50 grms. 66° sulphuric, at a temperature of 100° C. The pink crystalline mass so obtained was dissolved in water, and converted into the lime salt.

Calcium Salt.—This salt crystallizes with two molecules of water, in rhombic plates, and shows under the polariscope a beautiful effect of circular polarized light.

Formula.

$$a\ (C_6\ H_2\ (C\ H_3)\ (C_3\ H_7)\ (O\ H)\ S\ O_3)_2\ Ca + 2H_2\ O.$$

a. Calcium salt of alpha thymole sulpho-acid.

Ammonium Salt.—This salt was obtained by decomposing the lime salt, with ammonic carbonate. It crystallizes in white rhombic plates, with 2 mols. of water.

Formula.

$$a\ C_6\ H_2\ (C\ H_3)\ (C_3\ H_7)\ (N\ H_4\ S\ O_3)\ a\ H + 2\ H_2\ O.$$

The sodium salt has likewise been obtained, and will be described in a subsequent paper.

Remarks were made by Mr. JAMES D. WARNER on the nature of the corona of the Sun, etc. Mr. STEBBINS reported the yellow coloration of the atmosphere in September at the Thousand Islands in the St. Lawrence.

October 17, 1881.

SECTION OF GEOLOGY AND MINERALOGY.

The President, Dr. J. S. NEWBERRY, in the Chair.

Fifty-one persons present.

Dr. NEWBERRY exhibited specimens of native lead and oxide of lead from a mine in the Wood river country, Idaho, crystallized gray copper, and fine crystallized rhodochrosite from the Ulay mines, Southwest Colorado.

Dr. T. EGLESTON pronounced the crystals of Rhodochrosite the finest he had ever seen, and probably the finest specimens ever yet found.

He stated to the Academy that since its adjournment in June he had made the discovery of tellurium in certain copper products from Colorado. The sample examined had been found to work unsatisfactorily and was supposed to contain arsenic and antimony, as the pig yielded dense white fumes in the furnace. After a careful examination no arsenic nor antimony was found, but nearly one half per cent of tellurium. The fumes poisoned the furnace, and the copper manufactured cracked in the rolls, was useless except for brass of poor quality, but was quite suitable for the manufacture of cupric sulphate. A number of ounces to the ton of silver and gold were found in the same copper, but too little to make a metallurgical separation possible.

Dr. Egleston also announced that after making a long series of examinations on the presence of silver in Lake and other brands of commercial copper, he had come to the conclusion that the silver was very unequally distributed in it; as assays taken fifteen minutes apart from several different charges, during the last two hours of the process while ladling, show the quantity to vary as much as eight or ten ounces in the different assays.

Dr. J. S. NEWBERRY remarked on:

GEOLOGICAL FACTS RECENTLY OBSERVED IN MONTANA, IDAHO, UTAH AND COLORADO.

Idaho and Montana.—The famous placers at Helena and Virginia, which have yielded thirty millions of dollars, are now exhausted, but vein-mining is in successful progress and yielding rich results at Butte, at the Alice, Lexington, Copper Bell, and other mines. These are true fissure veins, traversing a granite formation, and the speaker predicted their abundant yield of silver and copper twenty years hence. These territories have been simply crossed by two government expeditions and their resources have not been at all studied. It is the coming mining region, more discoveries of promising mines having been recently made here than in any other portion of the country. On the east of the mountains in Montana and Wyoming lies a fine agricultural country and excellent stock range, the herds ranging freely throughout the winters, in spite of their severity, with little loss, and grazing upon a native bunch-grass (*Festuca scabrella*) and the buffalo grass (*Buchloe dactyloides*). The climate is salubrious, the country very beautiful in many parts and very promising for emigration. In the adjacent Rocky Mountains range there are also many mining opportunities.

The remarkable lava plain, 400 miles long by 75 miles wide, in Central Idaho, was then described. Snake River, one of the chief tributaries of the Columbia, flows along its southern border for several hundred miles; its northern tributaries sinking under the lava sheet and flowing in subterranean channels 50 or 60 miles long. The rock is a basalt said

to contain every where a small quantity of gold and silver. It is generally covered with an impalpable soil that produces a dust excessively annoying to the traveler, and sustains a general growth of sage brush. In places, however, the rock is bare and looks like a congealed stormy sea. Three buttes are set on the surface of this lava plain, and each has probably been a local volcanic vent; but it is probable that most of this eruptive material has been an overflow from great fissures of which the position is not indicated on the surface. Snake River crosses a portion of this plain in a cañon, at the head of which are the great Shoshone Falls, 208 feet in vertical altitude.

An alluvial plain borders Snake River for 200 miles, abounding in black sand which contains much gold. This is, however, extremely fine, having been transported a long distance from its place of origin, and therefore difficult of separation. New and promising methods and machines are about to be tried in the exploitation of these extensive deposits. A wide mountain belt extends from the north side of the lava plain to and beyond the British line, and is apparently a good mining country throughout. Already a great number of productive and promising mines are opened in the southern portion of this belt. In the Wood River district the veins are not large, but numerous, regular and persistent, and the ore of high grade—mostly argentiferous galena, carrying $100 to $500 in silver to the ton. Near Challis, further north, is the celebrated Ram's Horn mine, located on a true fissure vein, generally not more than five feet wide, but continuous for more than five miles. The wall rocks are slate, the veinstone siderite (carbonate of iron), the ore gray and yellow copper, yielding $100 to $1200 in silver to the ton. A few miles west of Challis is the mining town of Bonanza, where are located the celebrated Charles Dickens and Custer mines, carrying both silver and gold. Still further West in the Saw Tooth range, a high and very picturesque mountain chain running north and south, recent discoveries of valuable mines have been made. From this district north to the Canadian line, a broad mountain belt extends over northern Idaho and northwestern Montana, a country which abounds in veins of silver, copper and gold. Among the mines now worked in this region the most celebrated is the Drum Lomond, in Montana. It is opened on a large vein of rich quartz, and is owned by an old miner who cannot read, but who is said to have refused a million of dollars for the property. It is probably worth much more than this.

Most of the mountainous districts of Idaho and Montana are covered with coniferous forests, consisting of the Douglas spruce and the northern nut pine, *Pinus flexilis*. The smaller plants form an Alpine flora of much interest, including many beautiful flowering species;

perhaps the most striking being *Bryanthus*, which has a fine fir-like foliage and clusters of beautiful purple flowers. It belongs to the Heath family, and closely resembles the heather of Scotland.

The streams of this region are clear, cold, and rapid, and abound in fish, chiefly of the salmon family, and these have given the name to Salmon River, the principal water course.

Two species of salmon were running up the Salmon River, one the large Quinnat or Chinook salmon, comparatively rare, and the other the "red fish" (*Oncorhynchus nerka*). This is a small salmon, 15 to 18 inches in length, and weighing 3 to 5 pounds. As seen in their migration their bodies are brick red to purple in color, the heads dark or light green; they were then going up to their spawning ground, Redfish Lake, one of a half-dozen of small lakes on the headwaters of the Columbia, which are the special breeding-places of this interesting fish. Coming all the way from their abode in the ocean, led by an infallible but inscrutable instinct, they push on night and day till they reach their remote birthplaces in these little lakes far up in the mountains and 1000 miles from their starting point. Here they accomplish apparently the great object of their lives, the reproduction of the species, by depositing the spawn in the shallows of the rivulets which fall into the lake.

The always attractive coloring of the fish during this nuptial season becomes greatly heightened; the body assumes a brilliant, almost luminous red, as bright as that of the gold fish, and where numbers are dashing through the water, literally in a blaze of excitement, they produce an exhibition that is strikingly novel and interesting.

When the spawning season is over they probably do not return, as none are seen descending the rivers. The young fish start on their migration to the ocean while yet very small, and within the first year of their lives, remaining away it is supposed some three or four years, during which they acquire their full growth when they return to die where they were born.

An active industry has grown up in the capture of the red fish in their annual migrations, but it is pushed with so much energy and unsparing cupidity that their numbers are rapidly diminishing and the species will apparently be soon extirpated in these waters unless protected by legal enactment.

A branch of the Union Pacific Railroad is being constructed from Granger, Wyoming, to the mouth of the Columbia. On this a large amount of traffic is expected, as it will link together many settlements having a considerable resident population and traverse in different portions of the route rich agricultural and mining districts.

Dr. Newberry then briefly described a small but remarkably rich

placer gold deposit he visited on the west flank of Mount Wheeler, the highest mountain in Nevada, and mentioned the discovery of an outcrop of lower silurian rocks full of fossils, including several new trilobites, discovered by him in Southwestern Utah, but deferred all details till he should make them the subjects of special remark to the Academy.

Colorado.—Reference was made to the general character of Southwestern Colorado, the interesting topography of the region, especially the vast plateau which rises westward from the base of the Rocky Mountains on to the slopes of the Wahsatch ; the ascent of Marshall's Pass by the Denver and Rio Grande Railroad, the most remarkable feat of railroad engineering performed in the country, and the exceedingly picturesque region about the Pagosa, the greatest hot spring on the continent. Where the San Juan River issues from the mountains a prairie occurs, surrounded by picturesque forest-clad hills, and with a beautiful view of snow-clad mountains in the distance. In the centre of the prairie lies a basin 40 by 60 feet across, boiling like a huge caldron, the ebullition being produced by the violent escape of carbonic acid gas. The banks are lined by the remains of beetles, snakes, etc., destroyed by too trustful reliance upon the hot waters, and by interesting mineral deposits. This is one of the most beautiful places in the country and likely to be a famous resort.

Along the route from Pueblo to Gunnison and Lake City, and thence eastward by Del Norte, there are some places of resort for invalids and pleasure-seekers, which are destined to be very well-known, being far more beautiful and salubrious than the now celebrated localities at Manitou and Colorado Springs. One of these is Wagon Wheel Gap, on the Rio Grande. The river is a rapid, turbulent stream, and the Gap is seven to ten miles long, just wide enough to permit a wagon-road. Then a wide, open space is reached, the basin of an ancient lake, girdled by a wonderfully beautiful amphitheatre of mountains. Here 8500 feet above the sea, the hot springs, charming rides, fine hunting and fishing, an atmosphere as pure and clear as crystal, constitute the attractions of a resort, which far surpasses any other, and which will be reached by the railroad now being pushed through the Gap about January 1, 1882.

From Gunnison, specimens have been recently brought of magnetite and hematite, which probably represent inexhaustible masses, and at Crested Butte, within twenty-five miles of this locality, is found the best coking coal in the West. The region borders on a volcanic area, and the coking coal is from that portion of the basin which has mostly escaped the alteration by volcanic heat. It is firm and not affected by the weather, with a small amount of ash and sulphur.

On Anthracite Creek are found many thousand acres of anthracite of better quality than that of Pennsylvania. Recent analysis made at the School of Mines, New York, shows it to contain less than one per cent. of sulphur, and three per cent. of ash.

The forest vegetation of Colorado is very simple. The pinion or nut pine is very common, also the yellow pine (*P. ponderosa*), Douglas' spruce, Menzies' spruce, etc. In the mountains the general vegetation is picturesque but not so varied as in the lowlands. The following plants are among the most characteristic in the lowlands of Colorado and Utah.

The evening primrose (*Œnothera Cæspitosa*), with its large beautiful white flowers.

The wild tobacco (*Nicotiana attenuata*).

The sun flower (*Helianthus*).

The bee flower (*Cleome integrifolia*), presenting purple acres by the roadside, and the yellow species (*C. lutea*) less common.

The American primrose (*Primula Parryi*).

The pasque flower (*Anemone patens, Var. Nuttalliana*).

The *Eriogonums*, about twenty species, coloring whole mountain sides yellow.

The Oregon grape (*Berberis aquifolium*).

Phacelia circinata, in tufts of purple flowers on rocky slopes.

The lily (*Calochortus Gunnisoni* and *C. Nuttalli*), or "black-eyed Susan" (Indian—"Seego"), very plenty in the moister portion of the sage-plains.

The clematis (*Anemone alpina*), with its purple flowers.

The penstemons, of which 20 or 30 species are peculiar to that county, deep crimson, pink, and purple and blue in color, often very showy, and so abundant that whole acres of ground are colored by them.

The columbine (*Aquilegia canadensis*), and also a much larger species (*A. cerulea*), clothing the mountains of Colorado and Utah, with blue, cream-colored, and white flowers. A large number of dried plants were exhibited from a collection of several hundred species just brought on from Colorado, with collections procured from Prof. Marcus Jones of Salt Lake City, and others.

October 24, 1881.

SECTION OF PHYSICS.

Vice-president, Dr. B. N. MARTIN, in the Chair.

Thirty-one persons present.

Mr. W. LE CONTE STEVENS read a paper, of which the following is an abstract.

WHEATSTONE AND BREWSTER'S THEORY OF BINOCULAR PERSPECTIVE.

For some time after the publication of Sir Charles Wheatstone's essay (1) in 1838, on the Physiology of Vision, this subject was studied with much zeal by Sir David Brewster, whose name is permanently associated with the lenticular stereoscope, an instrument now familiar in every household. Although the theories advanced by these two physicists to account for the illusion of binocular relief have since been shown insufficient, their mode of accounting for the estimate of distance as perceived in the stereoscope has been quite generally accepted. In 1844, Brewster published an essay (2) "On the Knowledge of Distance given by Binocular Vision," in which he elaborated and abundantly illustrated the idea that the apparent distance of an object is determined by the intersection of visual lines. The stereoscope had already been explained as an instrument by which rays of light from two slightly dissimilar pictures were made to enter the eyes, as if coming from a single object into which they are combined in front, and on each point of which the visual lines could be made to meet. Thus, in Fig. 1, if rays from the conjugate foreground points, A_1 and A_2, be

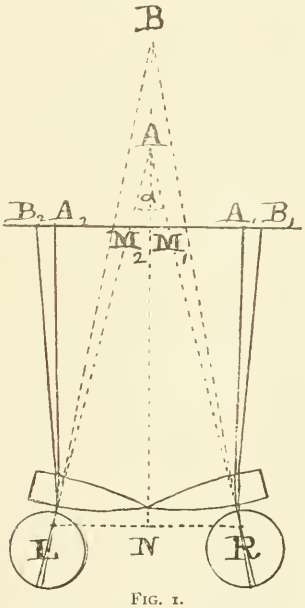


FIG. 1.

(1) Phil. Transactions, 1838, Part II.
Reprinted in Phil. Magazine, s. 4, vol. III., April, 1852.
(2) Edinburgh Transactions, vol. XV., Part III., p. 360.

deviated by the semi-lenses, they appear to have come from A. In like manner, the background appears at B. If i = interocular distance RL, and a = optic angle, then for the distance of A we have

$$D = \tfrac{1}{2}\, i \cot \tfrac{1}{2}\, a$$

From this formula it is obvious that D ceases to have any positive finite value when the visual lines cease to converge.

If the semi-lenses be taken away, and A_1 and A_2 be removed to M_1 and M_2 respectively, while the convergence of visual lines remains unchanged, the images still appear at A and B. Wheatstone seems to have been the first to show experimentally that the illusion of apparent solidity can be obtained in this manner from a pair of projections representing the same object from slightly different points of view. If the eyes be properly trained, the visual lines may be directed to points whose distance is greater or less than that of the objects regarded at the same moment, and Brewster described many striking illusions thus obtained without the aid of the stereoscope. The principle applied by him, as described in the paper to which reference has been made, may be briefly given, and his results can be easily tested by any one who is accustomed to analyzing his own visual sensations. Upon a uniform horizontal surface (Fig. 2) let two lines, A C and B C, be drawn, form-

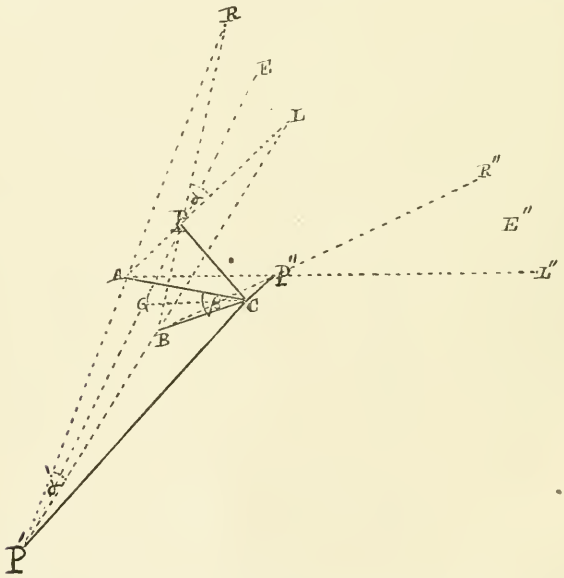


FIG. 2.

ing a small angle, β, with its vertex toward the observer. Let the eyes,

R and L, be placed above this. If they be directed to the point C, this appears in its true position. If the right eye be directed to B and the left to A, the axes meet at P; this point Brewster calls the binocular centre; and since the retinal images of B and A correspond, the visual effect is that of the union of these two external points at the binocular centre. Sweeping the glance toward C, the two lines appear united in the air, and P C is the apparent position of the combination, intermediate in direction between two monocular images, which may be disregarded or hidden from view with screens. If the convergence of visual lines be now diminished, the binocular image is lost until the right eye becomes directed to A and the left to B. The two points appear united at P′, and the line P′C now appears in the air on the further side of the surface. If the convergence be increased till P is again the binocular centre, and the face be lowered and withdrawn till the eyes are at R″ and L″, then C P″ becomes the position of the variable external image. And if lowered until R″L″ coincides with the surface, C P″ vanishes at the moment of becoming coincident with the prolongation of G C, the median of the triangle A C B.

Brewster's formula for determining the distance of the binocular centre from G is easily deduced and applied.

Let i = interocular distance, R L.

" a = interval between the corresponding points, A and B.

" b = distance, G E, between card and observer.

" x = distance G P, or G P′, which is positive when measured toward the observer, negative in the direction opposite. Then, observing the usual rule of signs, we have, by Geometry,

$$x = \pm \frac{a\,b}{i \pm a}$$

Applying this formula, Brewster constructed a table of distances for the binocular centre. For negative values it is seen that x becomes infinite when the visual lines become parallel; and, if they be slightly divergent, the binocular centre is far in the rear of the observer. Either of these conditions would make binocular vision impossible if the theory be correct. In testing the experiment with trained eyes, it is found quite possible to secure binocular fusion of the images of A and B when the interval between these points equals or slightly exceeds the interocular distance. It is also found that fusion of the images of the whole line at any given instant is impossible, especially when the angle β is large, or the lines are viewed very obliquely, as from R″ and L″. If the images of A and B fall on corresponding retinal points, the resulting sensation is binocular fusion, whether the visual lines be convergent, parallel or divergent; and the images of any

two points nearer or farther apart cannot fall on corresponding retinal points at the same moment with those of A and B, though small differences are easily neglected. Whatever may be the importance therefore of optic convergence, as a factor ordinarily in determining the binocular judgment of distance, it has no such exclusive and measurable value as that attributed in Brewster's experiments; and the apparent distance of objects viewed through the stereoscope is obviously not determined by intersection of visual lines, if conditions are such as to render these parallel or divergent. The visual effects of optic divergence can be more conveniently studied by using stereographs than by the method already described, and a modification of Wheatstone's reflecting stereoscope affords the best means of measuring variations of the optic angle. As the lenticular stereoscope, however, is now almost universally employed, it is important that this instrument, as found in the market, be examined first.

By diminishing the natural convergence of visual lines, the stereoscopic effect of binocular relief can be quite easily obtained, while gazing upon a stereograph, without any instrument, when the interval between corresponding points of the two pictures does not exceed that between the observer's optic centres. This distance does not often differ very much from 64 mm., which may be taken as an average value. In Fig. 3 the distance between the two central dots is 50 mm. If the reader will fix his gaze upon a point ten feet off, just visible below the edge of the page, and then suddenly raise the visual lines to the figure without changing their convergence, he will see three circles instead of two; the central one moreover will appear as the base of a cone whose vertex is pointed toward him, but capped with a small circle. A little attention then will reveal the fact that when the dots are seen distinctly and singly, the small circle is double and slightly indistinct, and *vice versa*.

On stereographs, however, the interval between corresponding points is always greater than 50 mm. As the result of measurement made upon the foreground intervals of 166 cards, European and American, taken at random, the mean value I have found to be 72.9 mm., the maximum being 95 mm. If binocular combination is secured without

Fig. 3.

the stereoscope, therefore, optic divergence is nearly always necessary. To ascertain the extent to which this is counteracted by the semi-lenses of our best stereoscopes, 30 pairs of these were kindly loaned me by Mr. H. T. Anthony, of New York. With very slight variation, their focal length was found to be 18.3 cm., and their deviating power not sufficient to prevent the necessity of optic divergence, when the pictures are binocularly regarded through them, if the stereographic interval exceed 80 mm. As this limit is not unfrequently exceeded, optic divergence is often practiced unconsciously in using the stereoscope. Every oculist is familiar with the mode of using prisms to test the power of the muscles of the eyeballs, for both convergence and divergence of visual lines, and knows that 4° or 5° of divergence is not uncommon. Helmholtz (3) refers to the use of stereographs for the same purpose.

But familiar as is the production of optic divergence by artificial means, little or nothing seems to have been written in regard to the modification which the possibility of it imposes upon the theory of binocular perspective held by both Wheatstone and Brewster, accepted by most writers on vision since their time, and abundantly reproduced in our text books on Physics.* Of these I have not been able to find one that gives any account of the stereoscope except on the hypothesis that the visual lines are made to converge by the use of this instrument. On the uncertainty attached to the judgment of absolute distance from convergence of visual lines alone, Helmholtz (4) has written more fully than any one else. It is unfortunate that no English translation of his masterly work on Physiological Optics has ever been published. Although he gives no analysis of the visual phenomena produced in binocular fusion by optic divergence, his discussion of the judgment of distance would certainly tend to cast some doubt upon the explanation of vision through the stereoscope, as found in our text-books. And yet Helmholtz himself employs Brewster's theory in his mathematical discussion (5) of stereoscopic projection. This discussion, on the data assumed, is a model of elegance; but it contains no provision for divergence of visual lines. It is strictly applicable to the conditions involved in taking photographs with the binocular camera,

(3) Helmholtz, Optique Physiologique, pp. 616 and 827.

* Nov. 15th. Since the above was put in type, I have received from Prof. C. F. Himes, of Carlisle, Pa., an article written by him in 1862, in which he mentions his successful attainment of binocular vision by optic divergence, and criticises Brewster's theory of distance in relation to the stereoscope. Though his observation was independent, as my own was also, I find that he was preceded by a German, Burckhardt, in 1860 or 1861. I have already referred to Helmholtz in this connection (*Am. Journal of Science*, Nov., 1881, p. 361), and therefore have claimed no priority in discovering the possibility of this unusual, but still voluntary, employment of the eyes. It is the more remarkable that in our text-books the assumption should be so universal, that convergence of visual lines is a necessity in binocular vision for the determination of the apparent point of sight.

(4) Idem, pp. 823, 828.

(5) Opt. Phys., p. 842.

and to the projection of images viewed in the stereoscope when the convergence of visual lines is identical with that of the camera axes, but not otherwise. Instead of human eyes we may assume a pair of camera lenses, an interocular distance apart, and a pair of sensitized plates behind them. Helmholtz's formulas enable us to determine the stereoscopic displacements in the images projected. If proofs from the negatives thus obtained be inverted and placed in front of a pair of eyes in such manner that the visual lines passing through corresponding photograph points shall bear to each other the exact relation that existed between the secondary camera axes that terminated in them, these two points will appear as one, and nearly at the distance of the real point in space to which the camera axes were converged. The effect is much the same as if the eyes, with normal convergence of visual lines, had been substituted for the cameras. But if the proofs be too near together or too far apart, increase of convergence makes the whole picture seem nearer, while divergence makes it farther. The relation between the different parts having been fixed at the time the picture was taken, increased convergence makes the distance from background to foreground seem less, divergence makes it greater. No one can have failed to notice the gross exaggeration of perspective often seen in the stereoscope, when the pictures are so far apart as to make the visual lines parallel or divergent, while the angle between the camera axes, when they were taken, was relatively large. But in no case do these conditions cause variations of such magnitude as Brewster's theory of binocular perspective would demand. This is easily illustrated with Wheatstone's reflecting stereoscope.(6) Suppose the stereograph to represent a concave surface with the opening toward the observer, and that the arms of the instrument are properly adjusted. If they are pushed back, so as to make the visual lines divergent, the cavity apparently recedes and deepens; if pulled forward, so as to make them strongly convergent, it seems to approach and grow shallow. The apparent diameter of the image enlarges in the first case and diminishes in the second. Wheatstone notices this last variation in the account which he gave of his invention and its applications, in 1852, in the Bakerian lecture before the Royal Society (7); but, strange to say, the variation which is produced in apparent distance and depth under the same conditions seems to have escaped his notice, and the possibility of using his instrument to test the peculiarities of binocular vision with divergence of visual lines, seems not to have occurred to him. For the refracting stereoscope, however, like Brewster, he constructs a table of apparent distances corresponding to various optic

(6) For description, see Phil. Mag., s. 4, vol. III., June, 1852, p. 506.
(7) Phil. Mag., s. 4, vol. III., p. 504.

angles, and applicable in using the binocular camera for the purpose of taking slightly dissimilar pictures of the same object. He adds, (8) "when the optic axes are parallel, in strictness there should be no difference between the pictures presented to each eye, and in this case there should be no binocular relief; but I find that an excellent effect is produced, when the axes are nearly parallel, by pictures taken at an inclination of 7° or 8°, and even a difference of 16° or 17° has no decidedly bad effect. There is a peculiarity in such images worthy of remark; although the optic axes are parallel, or nearly so, the image does not appear to be referred to the distance we should, from this circumstance, suppose it to be, but it is perceived to be much nearer." This would not have seemed anomalous to Wheatstone, had he supposed binocular vision possible with divergence of visual lines, and entered into an analysis of the resulting visual phenomena. This analysis will be given in a future paper.

Oct. 31, 1881.

GENERAL SECTION.

The President, Dr. J. S. NEWBERRY, in the Chair.

Twenty persons present.

The following paper was read by Mr. JOHN H. FURMAN:

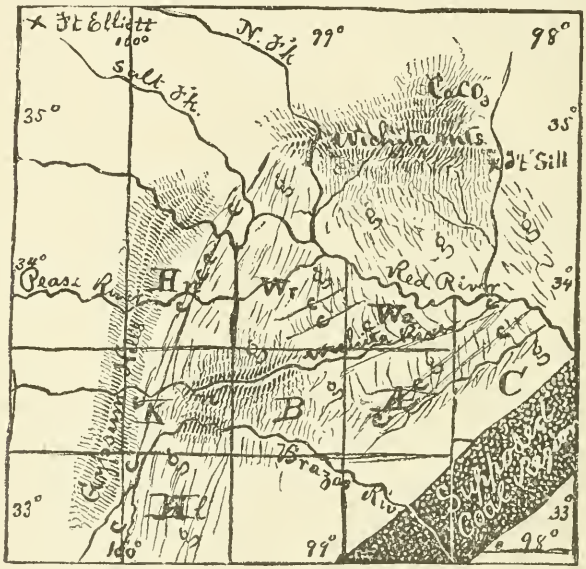
"THE GEOLOGY OF THE COPPER REGION OF NORTHERN TEXAS AND THE INDIAN TERRITORY."

The well-marked cretaceous beds of Parker County, Texas, extend for 30 miles north of west from Weatherford, on the road to Graham. They consist of strata of shelly limestone, sandstone and shaly clay, the latter grayish or reddish in color. An occasional thin seam of soft coal is found; and the water is strongly impregnated with lime. A stratum of sandstone stretches for thirty miles N. W. from Fort Worth. In this rock springs are found containing sodic carbonate, similar to the waters of the artesian wells of Fort Worth, Tarrant County, at a depth of about 270 feet. Towards Graham, the country assumes a semi-mountainous appearance, and, for twenty-five miles or more, sandstone ridges alternate with prairies, the hills being covered with scrub oak. Some of the ridges attain an elevation of two or three hundred feet above the prairies. The strata are horizontal, and large portions of the original surface have been carried away by erosion. The upper stratum is in many places a conglomerate, made up of small pebbles. In this region the seams of coal met with are generally soft, and the only workable

(8) Idem, p. 514.

bed known is one about three feet thick, yielding a fair quality of bituminous coal, which crops out and has been traced for several miles near the Clear Fork of the Brazos river in Young County. This supposed coal region has a general N. E. and S. W. direction.

Approaching Graham the prairies begin to resemble the plains; and the ridges, capped with sandstone, show bases of mottled reddish-colored shales, or clay; salt springs and salt streams are found, indicating the border of the great alkaline region. From Graham to Fort Griffin in Shackleford County, thence north in Throckmorton County, the country rises. Every few miles a steppe is mounted, the face of the escarpments showing horizontal thin limestone strata. The same features continue, and then the country slopes towards the Brazos river.



SCALE—52 MILES TO 1 INCH.

A.	Archer County.	*Wa.*	Wichita County.
B.	Baylor County.	*Wr.*	Wilbarger County.
C.	Clay County.	*c. c. c.*	Copper Bed.
Hl.	Haskell County.	*g. g. g.*	Gravel Drift.
Hn.	Hardeman County.	*n.*	Narrows.

Turning westward through Haskell County, the surface lowers again towards the Brazos, the river coursing south to north, and a plain is crossed, the ground differing from any observed. The soil is mixed and covered with gravel, in many places several feet deep. The pebbles

vary in size from half an inch to an inch and a half in diameter, and consist of feldspar, quartz, porphyry, and basalt. On the western side of Haskell County the copper bed is reached not far from the Brazos river; and west of the copper a great belt of gypsum hills, several miles in width, extends northward, parallel with the copper bed, into the Indian Territory. Gypsum occurs there in most of its forms, including selenite which has been locally mistaken for mica.

On reaching a scene of attempted mining operations in search of supposed veins of copper, a very short examination convinced me that no vein would ever be discovered. Denudation has laid the bed bare, sweeping away the larger portion uncovered and leaving only patches; but these were sufficient to give a clear conception of the mode of occurrence. The copper-bearing stratum is an ashy-colored clay shale, more or less tinged with green, the upper portion showing the deep green carbonate of copper, usually two or three inches thick. Overlying this stratum is a cap-rock of gypsiferous sandstone, about three feet thick, with a layer ⅛ to ¼ inch thick, impregnated with carbonate of copper, as though it had soaked it up from below. Underneath the gray or green bed an intensely red clay shale is generally found. Nuggets of copper are scattered over the surface of the red bed, with pieces of cuprified wood and nuggets of iron pyrites. In the wood the original structure in many instances is perfectly preserved, also appearing cuprified in all stages of decay, as though it had become half rotten before the petrifaction was effected. The overlying sandstone frequently contains biscuit-like concretions of gypsum. Juniper trees abound and also cover the gypsum hills, the perfectly preserved cuprified wood, with its knots and bark, showing a fac-simile of that growth. I found in the gray bed fragments of wood partially unaltered, as though it had just commenced to absorb copper; also large pieces of coal, three or four inches or more in diameter, the cracks of the same piece being filled with crystalline carbonate of copper, or with white gypsum, thus appearing veined with copper and gypsum. In parts of the bed remaining the resemblance to piles of ashes and charcoal is strikingly deceptive. In one shaft, sunk to a depth of about thirty feet, the horizontal position of the strata was confirmed, the shaft passing through the cupriferous gray bed, and then through a succession of layers of red shale and soft red sandstone, in which not a trace of copper was found. The gray stratum extends seventy-five feet or more under a point of the gypsum hill. In a tunnel traversing this stratum I noticed occasionally pebbles belonging to the gravel drift. This copper formation has a general north and south course, usually less than fifty yards in width, and was traced for a distance of eight or ten miles to the southern boundary of Haskell County.

At one point the gray bed lies between beds of sandstone; the red bed does not appear, and the underlying sandstone strata are almost white, laminated, and very hard. The bed is more than two miles distant from the gypsum hills; the gravel drift is noticeable and even abundant. Observing the nuggets of copper ore and the drift pebbles lying about in places on the red bed, the idea forced itself upon me that there might be a remote connection between the two. However, the nuggets of ore are evidently concretions, and no pebbles occur in the gray bed. The gypsum range extends several miles across, with a western declivity similar to that on the eastern side. A plain, a little over one hundred feet below, reaches beyond to the foot of the great Llano Estacado. On these hills and on this western plain the gravel drift is wanting.

The copper bed was traced five miles further to the north: also in Knox county, not far from the Wichita river, and forty miles or more north of the southern portion of Haskell county: its occurrence was also reported north of the Wichita river. The copper band here lies between the sandstone and gray bed, with the red beds beneath. Eastward, between the Brazos and Wichita rivers, the gravel drift is abundant, with many stones of greater diameter. At the "Narrows," between the Wichita and Brazos rivers, the width is only sufficient to admit the passage of a single wagon. Continued caving in of the bluffs of the two rivers has widened an immense eroded area, rendering a large surface valueless, and while the channels of the rivers are several miles apart, their junction is only a question of time. In the copper region of the little Wichita river, near the centre of Archer county, the ore occurs under the same general conditions, with a different course, N. E. and S. W., and copper nuggets, coal and cuprified wood are found.

Embedded in the overlying sandstone, in some instances several feet above the gray bed, the sandstone frequently attains a thickness of more than fifteen feet. The cuprified wood is altogether different from that of Haskell county, and resembles the wood of the mesquite tree, which I found scattered about. The gravel drift here is identical in character with that of the region further west, and pebbles occur in the gray copper-bearing bed beneath the sandstone. The extension of the gravel drift of Haskell county, beyond the Brazos river system, its absence west of the gypsum hills, the larger size of the pebbles in Knox county, bordering the Wichita river, and the occurrence of the drift only in the vicinity of the copper-bearing lines mentioned, and in Archer county, suggested to me a possible relationship of some kind between the two, perhaps their origination in the same region. Between the Wichita and Pease Rivers I crossed several copper-bearing

beds, having a general northeast and southwest direction. In Wilbarger County the gravel drift is in great quantity, and boulders from three to seven inches in diameter occur. In places, and having a northeast and southwest bearing, heavy deposits or lines of gravel and boulders attract attention, appearing as though a great flow towards the southeast had met obstructions along its course, the great incline of this region being directed toward the southeast. Beyond Pease River the gravel drift lessens, but the large boulders are occasionally seen as far west as the gypsum hills. Not far north from the centre of Hardeman County I again found the Haskell County copper bed, the accompanying sandstones being thin and much mixed with gypsum. The copper bed reaches higher than the surrounding country, except the gypsum hills to the west. From this high locality of the copper, known as Prairie-dog Mounds, the country inclines on one side northward to a creek emptying into Red River, and on the other side southward to the Pease River. South of these mounds, where only here and there patches of the bed are preserved in the midst of a general erosion, I found the largest mass of copper ore thus far discovered, consisting of an aggregation of cuprified wood, resembling the trunk of a tree, more than one foot in diameter.

Beyond Red River the bed continues to the vicinity of the Salt Fork of Red River, distant but little over 20 miles from the Wichita Mountains of the Indian Territory. The bed probably continues nearly to the western end of these mountains, and here must be found the true centre of elevation and the origin of the gravel drift. The Haskell County copper bed was also traced south to the Wichita River, thus establishing its continuity from the southern portion of Haskell County, through Knox and Hardeman Counties, into the Indian Territory, a length of more than 100 miles. Subsequently, the northern end of the bed was found a short distance from the western end of the Wichita Mountains, on the south side of the range. The copper formations of Archer and Wichita Counties continue through Clay County to the Red River boundary of the Indian Territory. The gravel drift does not extend to the north of the Wichita Mountains, but a limestone district occurs about 20 miles in width, that reaches probably as far out to the north, from the Wichita Range, the course of the latter being east and west. This limestone area may be called mountainous, is much disturbed and tilted, and is similar in appearance to the metalliferous limestone formation of Mexico. The Wichita Mountains are mainly made up of porphyries, trachytes and basalt, and appear to be two parallel ranges with transverse ranges and small valleys between. About 12 miles west of Fort Sill an extensive body of hornblende slate makes its appearance between the two main ranges. The drift from the mountains extends to the south and southeast. It is found as far west as the Haskell County copper bed, and as far east as the Archer County copper bed is known. The river channels of that section of the country have been formed since this drift period. The development of the Wichita Mountains seems to have marked the close of a period of uplift and simultaneous erosion.

These mountains have the same general appearance as the Rocky Mountains, which pass through the western portion of Texas and the State of Coahuila, Mexico; and it has been a matter of much interest to observe that similar drifts of local origin are frequently met in the latter regions. The Wichita Mountains appear to be identical in origin with the Rocky Mountains, and constitute the most eastern spur of that system. In Northern Mexico short ranges are encountered, striking east and west, and of these the Wichita Mountains appear to be a reproduction. The Wichita Mountains will be found to contain mineral deposits, possibly of some value; veins of copper ores do exist 40 miles west of Fort Sill, near Otter Creek, in the mountains; but I am convinced that the copper bed or stratum of Northern Texas will prove of no commercial importance.

DISCUSSION.

Prof. NEWBERRY remarked that the communication of Mr. Furman was of great interest, since no accurate description had before been given of the geological structure of the region where the copper occurs in northern Texas and the Indian Territory. He had received specimens from that region long ago and recognized their similarity to the copper ores of New Mexico, where in the upper portion of the Triassic formation copper forming concretions and replacing wood occurs in many localities, and has been more or less mined for. In one locality near Abiquiu very extensive galleries have been cut in the sandstone in search of copper which there replaces branches and trunks of trees and forms concretions which are irregularly scattered through the rock. Here the work was done by the early Spanish explorers perhaps 200 years ago, and the remains of the furnaces in which the copper was smelted are still to be seen at the mouth of the mine. Still further west, in southern Utah, the same formation carries copper and considerable silver, at Silver Reef enough to pay well for mining, but in no locality yet known are the deposits of copper ore sufficiently concentrated and continuous to make mining for that material profitable; so it would doubtless be found in Texas and the Indian Territory. The copper was deposited with the Triassic rocks from a shallow sea in which an unusual quantity of copper was held in solution. This impregnated the sediments found at the bottom, replacing wood and forming as nodules about some nucleus. The aggregate quantity of copper in this formation was enormous, but, except where by the erosion of the beds it accumulated at the surface and could be picked up without any expense in mining, it would hardly pay to attempt to obtain it by ordinary mining processes.

The wood replaced by copper, Dr. Newberry said, was undoubtedly all coniferous, and different from any now living. The beds which contained the cuprified wood also contained much that was silicified. Of this he had examined many specimens under the microscope and had found the peculiar dotted cells which are characteristic of the coniferæ, and these grouped in such a way as to prove the trees to have belonged to the Araucarian group of conifers. So far as yet known the angiosperms, or higher order of plants, did not make their appearance on the earth's surface until after the copper bearing rocks of the southwest had been deposited.

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November 7, 1881.

REGULAR BUSINESS MEETING.

The President, Dr. J. S. NEWBERRY, in the Chair.

Twenty-nine persons present.

A paper by Prof. P. T. CLEVE, University of Upsala, Sweden, was read by Prof. D. S. MARTIN, entitled

OUTLINES OF THE GEOLOGY OF THE NORTHEASTERN WEST INDIA ISLANDS.

(Abstract.)

Prof. Cleve's paper contained a resumé of his observations made during 1868–9, in and around the Virgin Islands, and published in the Swedish language in the *Trans. R. Acad. Sci.* of Stockholm, in 1871. He regards the whole group as of Cretaceous and Tertiary age, with the exception of Anegada, which, like the Bahamas, is Post-pliocene.

The strike of the rocks, and the trend of the entire group, are approximately east and west. The rocks are various, largely eruptive and metamorphic. Of these, Prof. Cleve discussed somewhat fully the character and distribution of the following kinds:—1, Dioryte; 2, Felsyte; 3, "Blue-beach" (a peculiar volcanic breccia, locally so-called); 4, Diabase.

All these rocks have great thickness, and indicate long-continued volcanic activity. As in modern lavas, they present two types, basic and acidic.

Metamorphic slates are next described; and then a partly metamor-

phic limestone, occasionally with recognizable fossils, sufficient to fix the age as certainly Cretaceous.

Santa Cruz Island is then described, and referred to the same series as the Virgin group. All these islands thus indicate, by their east and west strike, and the great up-turning of their rocks, that they were formed by a north and south pressure, forcing the Cretaceous and associated volcanic beds into a great line of anticlinal and synclinal folds. This period seems to have been about that of the white Chalk; but the force continued to act during the succeeding Eocene time, though with diminishing intensity, as is shown by the less inclination of the Eocene beds. The Miocene strata are little disturbed, and the force would therefore seem to have spent itself by that period.

Prof. Cleve then refers briefly to the occurrence of similar metamorphic and volcanic rocks in the interior of the Great Antilles, and regards the entire series as having been formed by the same general movement of Cretaceous folding, the Virgin Islands forming the eastern extension of the line of elevation.

The Eocene strata are then taken up and discussed, as they occur in the islands of St. Martin and St. Bartholomew, just east of the Virgin group. Professor Cleve regards these islands as wholly of Eocene age, claiming that the eruptive rocks, of which they mainly consist, are *interstratified* with the limestones, which contain fossils of the age of the Calcaire Grossier, of the Eocene of Paris. He then traces the occurrence of Eocene strata in Antigua, Guadaloupe, parts of Trinidad, and largely in Jamaica; and re-affirms his conclusion that the movement which raised the Great Antilles and the Virgin islands continued during the early Tertiary, though with lessening force.

The Miocene formation is then considered. It forms the small island of Anguilla, and occurs on several of the islands, south to Trinidad; but has immense development in the Great Antilles. It is chiefly a limestone series, is generally little disturbed from a horizontal position, and at times may be seen resting unconformably on the Eocene. By this time, evidently, the disturbing movements had ceased to make themselves felt.

The later Tertiary rocks, Pliocene and Post-pliocene, have not been very clearly marked off from each other or from the Miocene. But to the Post-pliocene period are referred the Bahamas, Anegada, and the remarkable series of volcanic outbreaks that characterize the islands of Saba, St. Eustatius, St. Kitts, Nevis, Monserrat, Guadaloupe, &c. On St. Kitts, Prof. Cleve describes a limestone with over forty species of fossil shells, all but one of which are identified with living species of the Caribbean sea. The same is true of Anegada.

The elevation of the Miocene strata of the Great Antilles took place

apparently by a "continental" up-lift, whereby large areas of marine deposit were raised without folding or disturbance. Professor Cleve suggests that this movement may have been accompanied by a sinking of part of the sea-bottom in the Caribbean region to the south-east, and that, on the limit between the areas of rise and of depression, fissures and faults may have occurred, through which these volcanic outbreaks of the Leeward islands found exit, in the Post-pliocene time.

DISCUSSION.

Mr. A. A. JULIEN confirmed the accuracy of these petrographical distinctions of the rocks of the Lesser Antilles, from the results of observation during a residence of four years on Sombrero and vicinity. The island of St. Eustatius consists mainly of volcanic ashes in a thick tabular and horizontal stratum with vertical faces along its coast. This is flanked on the south end by a volcanic cone with extinct crater, of which the bottom is occupied by a plantain plantation, but the sides are bare, and consist of a dark basaltic rock; and on the north end by two lower cones, not visited but probably volcanic. On the island of Saba the rock is light colored, rich in crystals of sanidine, and apparently a trachyte, constituting a remarkably sharp volcanic cone, with its sides deeply furrowed from top to bottom by eroded ravines; certain depressions upon the summit, resembling craters, present in some localities sulphur deposits which have been found of commercial importance.

However, the conclusion of Prof. Cleve, as to the recent age and eruptive character of most of the crystalline rocks of this region, appeared surprising in view of their metamorphic associates, and of their similarity to those of the Archæan areas identified by Hartt in Brazil. It was a question whether a nucleus of Archæan, or, at latest, metamorphic pre-Silurian rocks, in general highly tilted, does not form the axis of such islands as St. Martin, St. Barts, etc.

Prof. D. S. MARTIN questioned whether a corresponding movement of disturbance should not be also found in the Cretaceous strata of a region no farther removed than that of the vicinity of our own Gulf coast.

Dr. J. S. NEWBERRY remarked that the importance of the subject of the age and origin of these crystalline rocks still demanded their re-examination and a review of Prof. Cleve's conclusions by some worker of experience in this peculiar field. One of the most interesting topographical features on this continent consisted in the line or axis of elevation marked by the Windward Islands, separating the deep basin of the Gulf of Mexico on the one side from the abyss of the Atlantic Ocean on the other. It presents a prolongation and connection of the mountain chains which run along the eastern border of the North and

South American continents, in a course imperfectly parallel to that on the western border of these continents, with the gulf lying enclosed between these two great ranges. This axis has been the scene of violent volcanic action and has been supposed to mark the place of that mythical area of sunken land, styled Atlantis by the ancients. A tradition long current, recorded by Herodotus and others, points to a densely populated land west of Europe, covered with cities, and threatening the civilization of the Eastern hemisphere, which was punished by the gods by being sunk beneath the sea. According to the recent observations of an English geologist, Mr. Thomas Belt, this legend may have had some foundation in the former existence of a continent, now submerged beneath the Caribbean sea, through which the peaks represented by the Lesser Antilles constituted a mountain chain. Local disturbances have certainly affected this area, but we fail to find any evidence of corresponding disturbance in the Cretaceous strata of our southern States, except perhaps in continental elevations and depressions. Messrs. Guppy, Gabb, and others have studied the rocks of the region, but, up to this time, no one trained to the examination of the difficult phenomena and problems under discussion.

November 14, 1881.

SECTION OF GEOLOGY.

The President, Dr. J. S. NEWBERRY, in the Chair.

Twenty-four persons present.

A paper was read by Dr. ALEXIS A. JULIEN on

THE EXCAVATION OF THE BED OF THE KAATERSKILL, N. Y.

(Abstract.)

This paper was supplementary to one read before the Academy two years ago, concerning the phenomena of erosion, glaciation, etc., in the Catskill Mountains, in the vicinity of the Kaaterskill Clove.

Flexure of Strata.—Prof. James Hall has indicated the existence of four lines of flexure, running from N.E. to S.W., the synclinals occupying the summits of ranges, and Prof. Arnold Guyot locates one of these at Slide Mt. The dips at the entrance of the Clove vary from 8° to 10° to the W.N.W., becoming only 3° four miles to the westward, *i. e.*, more nearly horizontal towards a shallow synclinal fold supposed to occupy Hunter Mt.

One of the most interesting discoveries of Guyot was the linear series of three maxima of altitudes above 4000 feet, Slide Mt., Hunter Mt., and Black Dome. The gentle flexure of the whole stratum required to produce this line of maxima may be shown as follows, in the range

running S.E. and N.W. through Hunter Mt., 35 miles long. Toward the S.E., the descent from the crest of Hunter Mt. (Alt., 4038 feet), to Overlook Mt. (3150 feet), is 888 feet, in 9½ miles, equivalent to 1 in 56, or about 1°; toward the N.W., from Hunter Mt. to Utsyanthe Mt. (3203 feet), the descent is 835 feet in 25 miles, equivalent to 1 in 158, or less than ½°.

Another similar series of maxima, however, occurs further to the westward, consisting of Graham Mt. (3886 feet), Bear-pen Mt. (3545 feet), and Ashland Pinnacle (3420 feet), distant respectively 9, 12, and 15 miles westward of the former series. This southward convergence of the axes of these two folds may probably account for the increased protuberance and greater elevations in the Southern Catskills.

Newly determined altitudes.—Many new determinations have been made of points in the vicinity of the Clove, by means of an excellent aneroid, with constant reference to the numerous stations in the vicinity whose altitudes have been accurately obtained by Guyot. A few are here subjoined:

	Feet.
Hotel Kaaterskill, on South Mt.	2466
Parker Hill, summit	2565
Parker Mt., "high ledge."	2874
Clifton House	2101
Newman's ledge, on North Mt.	2486
Gap between E. and W. peaks, North Mt	3116
Toll-gate on Mt. House road	760

Glaciation of summits.—All the crests near the Clove have been now examined. On none above an altitude of 2900 feet have glacial striæ been found, in part because they consist of thinly laminated flags deeply disintegrated by frosts. The highest striæ discovered were found on Parker Mt., "High ledge" (2874 feet), running S. 18° W. (magnetic), and under the roots of a large tree on the SE. slope of Round Top, at an elevation of 2871 feet, running S. 35° E. However, in all cases, a marked difference exists in the slope of different sides of a peak, the E. and S.E. sides presenting a precipitous face, and the other sides more or less of a gentle slope, made up of low terraces.

The highest striæ yet found in the Catskills occur on Overlook Mt., at an elevation of about 3100 feet, implying a depth of ice in the Hudson Valley Glacier of about or at least 3200 feet. Within the Kaaterskill basin, several miles distant from the Hudson valley, the overflowing ice stream became shallower, having an altitude of about 3000 feet. It thus appears that the surface of the glacier inclined westward over these mountains, with a slope of 200 feet in 3 miles, 1 in 84, say about ½°.

The conclusions of the former paper have been confirmed by recent

observation, viz., that two glacier streams have swept over these mountains, the Continental Glacier from the N. W., submerging and carving out the highest peaks, and the Hudson Valley Glacier from the N., later, more shallow, bearing along vast quantities of materials derived from the crystalline and lower Silurian rocks of the Adirondacks and of the Helderberg Mts., and strewing the whole region with their boulders; and that no local glaciers have existed in the Catskills after the retreat of the Hudson Valley Glacier.

Tilting of the Catskill plateau.—In the previous paper an explanation had been given of certain facts which seemed to indicate that the whole formation had been gently inclined to the East and then to the Southeast, before assuming its present W. N. W. inclination, at a period far anterior to the Glacial epoch. A profile section of the ancient Kaaterskill valley was exhibited, reaching from Haines' Falls nearly to the junction of the N. and S. branches of Schoharie creek, proving the gentleness of the slope, the absence of rock, and the existence of a deep and narrow buried cañon, now filled up with moraine material and a capping of peat.

A comparison of the altitudes of Prattsville (1164 ft.), a point on the Western axis, 12 miles distant from the Kaaterskill Clove, and of the lip of the stratum above Haines' Falls (1857 ft.), at the head of the Clove, shows that a depression of the latter point below a line connecting these two points, even to the extent of a single degree, would cause a descent of nearly 700 feet from Prattsville to Haines' Falls, *i. e.*, toward the East. The excavation of the deep Kaaterskill and Plaaterkill Cloves could hardly have been effected by the small streams now occupying their beds. It is more probable that the Schoharie creek formerly flowed, at a higher level, to the eastward into the Kaaterskill Clove, and afterwards toward the south-east into the Plaaterkill Clove, before the latest tilting of the plateau to the W. N. W. caused a reversal of the flow of the stream, in the very opposite direction, through the greater part of the same valley. An objection to this theory presented itself in the obstacle which has created a turn to the S. W. in the North branch of Schoharie creek, near its junction with the South branch. But on recent examination this was found to consist not of rock but of a huge mass of coarse moraine material, deposited during the Glacial period on the southern slope of the Schoharie valley.

Sculpture of the plateau.—In a terrane consisting of strata which dip at varying and perhaps very high angles, the carving out of ranges and production of ravines and gaps may generally be assigned to the occurrence of flexures, of dykes or faults, or of beds whose material is unusually soft, fragile, or rich in minerals of easy decomposition. But the problem of topographical sculpture is less easily solved in a stratum

like that of the Catskills, consisting of a regular succession of layers which are horizontally homogeneous and from which the phenomena of disruption are absent. The original disintegration and erosion of the mass which resulted in the production of the ranges was perhaps mainly influenced by the direction of the jointage. With this the trend of the ranges in the vicinity of the Kaaterskill Clove appears to coincide. The ravines, cloves, and deepest notches and valleys may be attributed to the streams of the present hydrographical basins, or to those connected with the ancient eastward and south-eastward inclination of the stratum already considered. But recent observations on the juxtaposition and coincidence of the highest gaps in successive parallel ranges may possibly indicate the remnants—in cross-section—of the beds of ancient streams at that level (about 3000 feet); this conclusion, if confirmed, would signify an inclination of the plateau to the N.N.E. (or to the S.S.W.?) at a still earlier period, that immediately succeeding its elevation.

Kames.—In the upper basin of the Kaaterskill, several isolated hills of gravel, etc., occur at an altitude of 1924 feet, especially on the bank of the stream near the head of the Clove, which are probably kames; their materials, though largely angular, show traces of imperfect stratification. Near "Blythewood," on the North branch of the Schoharie creek, a curious conical and steep isolated kame rises 102 feet above the stream, made up of rounded pebbles of the Catskill grit, rarely a foot in length, overlying a layer of coarse moraine. Its elevation above the sea (1944 feet) exceeds that of any other kame yet observed, those of the Fintry Hills in England reaching 1280 feet, and those of the Androscoggin Lakes, in Maine, 1600 feet. A very interesting series of from eight to twelve very low kames—like parallel ridges, often curving, made up of large rounded boulders—was also found to follow the course of the Kaaterskill near Palenville, in the Hudson Valley, at the mouth of the Clove, at an elevation of about 700 feet; these probably mark the course of the sub-glacial stream which issued from the mouth of the Clove. The paper concluded with observations on a deposit of laminated sand underlying the ground moraine: on the feeble erosion of the slopes of the Clove during the period which has elapsed since the close of the Glacial epoch; and on a new section of the strata of South Mountain obtained from a recent road cutting.

Discussion.

Prof. E. C. H. Day observed that one portion of Dr. Julien's remarks reminded him of an idea which had struck him many years ago, with regard to the surface geology of a valley on the south coast of England, near Charmouth, in Dorsetshire.

The stream in the valley referred to finds its way to the sea through a narrow pass, which, as attested by the rapid wearing of the coast line and its present configuration, could only have been of (geologically speaking) very recent origin. How the valley could have been drained prior to the existence of this outlet was a question which might be met by various hypotheses; and one of these was that there might have been a slight unequal local change of level, sufficient to have had the effect of tilting the surface of the valley, so that its waters were shed then in a direction opposite to that which they now take. This was nothing more than the veriest hypothesis, made many years ago, without any subsequent attempt at verification. It may suggest, however, the possibility of such slight local changes occurring, in addition to the greater movements already distinctly recognized, and the desirability of careful investigation to discover whether such may not be traced in the altered direction of streams and in the existence of ancient and unused water courses—even in our own neighborhoods. It may be added that such local tiltings of parts of the earth's crust would necessarily influence the course of subterranean as well as of subaerial waters, thus altering the distribution and force of springs at the surface.

Dr. J. S. NEWBERRY stated that the Catskills presented a more complex bit of topography and geology, and one that had been more discussed than perhaps any other of similar area in the country. It was once supposed that these mountains were composed of a single geological formation, which, from this fact, was called the Catskill group; and it was supposed to be a detached table land, deeply carved by erosion. The late Col. Jewett, of Albany, found strata containing Chemung fossils in the Catskills, and from this inferred that the mountains were composed of Chemung strata. Prof. Hall and Prof. Guyot, with their assistants, then made a careful study, running through several years, of the topography and geology of all the surrounding region. Their labors established the fact that the Catskills are not an isolated mountain group, but belong to the Alleghany system and are formed by a series of folds or arches composed of the Chemung and Catskill rocks. Of these folds, the convex arches, as is usually the case, were cracked and broken and, therefore, yielded readily to erosion, while the concave arches, protected and solid, yielded less readily and, in time, by the wearing away of their surroundings, were left in relief, forming ridges with a synclinal structure. Hence it will be seen that the topography of the Catskill region is chiefly the result of erosion.

So far as regards the changes of level from subterranean causes, referred to by Mr. Julien, it would certainly be strange if the foundations of the Catskills were proved to be stable. The old name, "*terra firma*," once applied to the crust of the earth, is a complete misnomer.

and it is really a type of instability. Probably throughout the globe local subsidence and elevation are constantly in progress. In the interior of continents we have no evidence or measure of these, but along coasts the water line tells us that changes are constantly and everywhere taking place, in the relative level of land and sea. About New York the coast is sinking, though very slowly, while further north, in places, it is rising, and Greenland is sinking again. Back from the coast there is no such nilometer, and yet we have no reason to suppose that the earth is more fixed. Some indication is given by the reports of those who dwell in mountainous regions, of changes of level, which have shut from their view that which was before visible, or revealed what was before concealed; but these observations have not been made with accuracy and cannot be depended upon.

In a recent paper before the Academy he had shown the vast changes which had occurred along the coast in this vicinity, viz., that the land once stood 600 feet higher than at present: that the Hudson river had then flowed by the city through a channel from 300 to 500 feet deep, now in large part silted up: that the Palisades then stood from 700 to 800 feet above the river: that the Housatonic then flowed through the East river into New York Bay: that a sub-tropical climate then prevailed throughout this region, with a varied and rich fauna and flora, extending up even to the Arctic Sea: that then a depression of the temperature and great change in the climate ensued, with a corresponding alteration of the fauna and flora; but that these changes were very slow and progressive—the snows, which at first rested temporarily upon the Catskill Mountain summits, became at last permanent, and resulted in local glaciers. These glaciers produced extensive erosion, cutting deeply the channels along which they moved. A partial obliteration of their work then ensued through two agencies. First, a continental glacier advanced southward, overtopping all the mountains, grinding down the asperities of the surface, filling old valleys, and banking up a great mass of debris along its margin—a part of which is now Long Island. Afterward, the climate becoming milder, local glaciers were again formed similar to those which preceded the great Glacier, and partially obliterated or modified the results of the ancient erosion. It is a complex problem now to distinguish between the phenomena which have been respectively produced by all these glaciers in varied succession, by the erosion of streams, by flexures of the earth's crust, etc.

The excavating power of glaciers had been denied by some persons; but ice, hundreds of feet and sometimes miles in thickness—as it was in the old glaciers—moving with irresistible force, and having sand, gravel and boulders beneath it, or frozen into it, was the most potent

agent of erosion known. The eroding power of the ancient glaciers, which once reached southward to Trenton and Cincinnati, was attested not only by the planed down rocks, but by the immense sheet of transported debris left by the glacier in its retreat.

The glaciated, planed, and polished rocks in the Western States are generally covered by a thick layer of clay, abounding in glaciated boulders. There are also other water-worn materials which have been transported, perhaps thousands of miles, representing the gravel bars sand beds, etc., produced by sub-glacial rivers. Although the materials are entirely of glacial origin, all the stones are here usually rounded. We find in these deposits, called kames or eskers, the evidences of the action of running water produced by the melting of ice, their accumulation in heaps, ridges, etc., having been effected by local causes, waterfalls, streams upon or under the ice, etc.

The finer material produced by the same grinding action has been deposited along our coast in the vast masses of the Champlain clays. It is well known that the drainage of all glaciers results in milky streams; *e. g.*, those which descend from the Alps impart an opalescence to the Lake of Geneva, and the streams from the Cascade Mountains are clouded with silt derived from the small glaciers at their heads. So, during the Glacial period all the fine material was sometimes washed out of the glacial drift, leaving banks and ridges, kames, hogsbacks, etc., of gravel and boulders, and carried by streams to the coast and there deposited along shore in the Champlain clays. The fine flour and bran ground by the glaciers have been sometimes referred to different epochs, but they are produced simultaneously. The Glacial or Champlain clays are of great economical importance to the city, as they are the brick clays of Croton Point, Haverstraw Bay, and other points along the Hudson. Their thickness reaches 100 feet along the lower portion of the Hudson river, 400 feet on Lake Champlain, 500 feet at Montreal, 800 feet at Labrador, 1000 feet at Davis' Strait, and 1800 feet at Polaris Bay. This indicates that the continent was depressed to this extent at each of these points, that the waters of the ocean extended through these valleys, and that here was dead water into which the glacier drainage flowed and was deposited.

In the vicinity of New York City it is evident that the glaciers everywhere over-rode and disregarded the underlying topography. All the surface of the island is strewn with materials derived from the N. N. W., and the rock has been planished and striated with grooves running in that direction. The hills back of Yonkers are covered by trap boulders, which have been conveyed across the river from the Palisade range on its western side; and it is plain that the glacier completely disregarded the depression of the Hudson valley, filled it up to a greater or

less extent with *debris*, and so rode smoothly over it. Afterwards this and the other valleys were more or less cleared out by the present streams, but a portion of their contents is generally left in their beds, the tunnel between this city and Hoboken being now driven in fact through a part of this clay deposit. On the east side of the city a narrow cañon, 300 to 400 feet deep, has been proved to underlie the East River; and it would have been a wiser and cheaper plan to construct a tunnel through the clay bottom, for communication with Brooklyn, in place of the present costly and to some extent insecure bridge.

Dr. Newberry finally expressed his interest in the careful study of the erosion and sculpture of the Catskills and desire for its continuance.

November 21, 1881.

SECTION OF BIOLOGY.

The President, DR. J. S. NEWBERRY, in the Chair.

Thirty-one persons present.

The following paper was read by Prof. LOUIS ELSBERG, M. D.:

ON THE CELL-DOCTRINE AND THE BIOPLASSON-DOCTRINE.

Mr. President and Fellows of the Academy, Ladies and Gentlemen:—Last May, at the meeting of the American Laryngological Association, I rendered account of some histological investigations of the cartilages of the larynx, a report of which is published in the October number of the *Archives of Laryngology*. As the structure of hyaline cartilage has an important bearing on my subject of this evening, I crave your attention for a few minutes for a brief review of those investigations.

You know the larynx or voice-box consists of a framework of cartilage or gristle. This cartilage is called hyaline or glasslike, because it is opalescent and looks like milk-glass. Having frequently been examined under the microscope, it has always been looked upon as one of the simplest tissues, namely, as being composed of a hard matrix or basis-substance, in which are imbedded a number of small softer bodies. These softer bodies, the cartilage corpuscles, have since the establishment of the cell-doctrine been called cartilage cells. As these cells were known to be alive, the question which scientific men have had to try to answer was: how can they obtain nutrition, being isolated and enclosed in the firm, unyielding cartilage basis-substance?

Without going too much into details, I may say that it was assumed that nourishing liquid reaches the corpuscle either by imbibition and diffusion or else through canals or fissures in the homogeneous basis-substance. The idea of the existence of "juice-channels" originates with Von Recklinghausen, although others before him had spoken

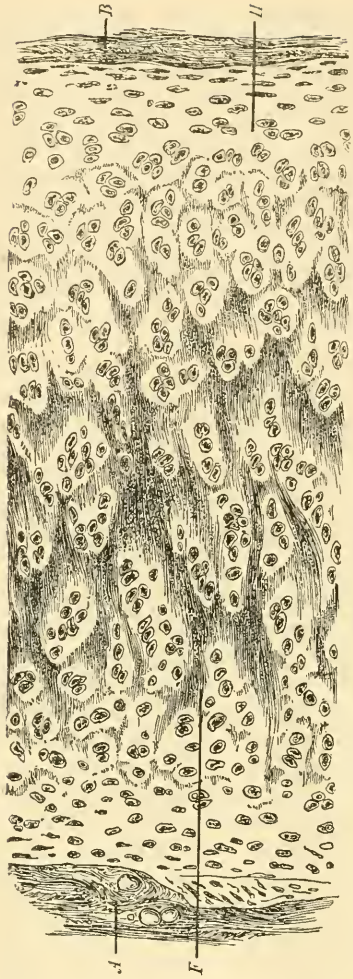

FIGURE 1.—Plate of the Thyroid Cartilage of Adult. Longitudinal Section x 100.

A. Perichondrium towards the mucus membrane. | F. Fibrous portion of cartilage in the centre.
B. Perichondrium toward the skin. | H. Hyaline portion, on either side, near the perichondrium.

FIG. 1 exhibits the appearance of a longitudinal section of the plate of the thyroid cartilage, with an amplification of 100 diam.

of "pores" through which nutrient juices might pass. Budge and others believe in the presence of regular canals for this purpose, while Tillmanns and many with him believe that hyaline basis-substance consists of fine fibrils so closely held together by a cement-substance that the mass appears to be homogeneous. It is supposed by some that this inter-fibrillar cement-substance is a viscous soft material which permits the imbibition of nutrient liquid; by some that there are clefts or fissures; and by others that there are regular channels tunnelled in this cement-substance. On the other hand, Heitzmann, Spina, Flesch and others have found that there are cilia-like offshoots or prolongations of the substance of the corpuscle penetrating into the basis-substance. Such prolongations might carry on nutrition. I have had the opportunity, six or seven years ago, to repeat Heitzmann's observations under his own eyes and with his assistance; but the results as to their correctness, at which I arrived, were to the best of my belief uninfluenced by him.

My own recent investigations have not only confirmed the existence of such offshoots and shown that they form an inter-connected reticulum or network throughout the basis-substance, but I have discovered in several specimens small lumps in this network which, by all the tests applied to them, were proved to be lumps of living matter in

various stages of existence! These investigations are illustrated by the accompanying drawings.

Doubt as to the interpretation is impossible: instead of being a mass of basis-substance in which a number of cartilage corpuscles are imbedded, hyaline cartilage is a filigree of living matter, in the meshes of which a number of blocks of basis-substance are imbedded.

Now, for our subject proper.

The founder of the cell-doctrine, Schwann, has recorded in the introduction to his great work, published in 1839, that the doctrine was based to a large extent upon investigation of the constitution of carti-

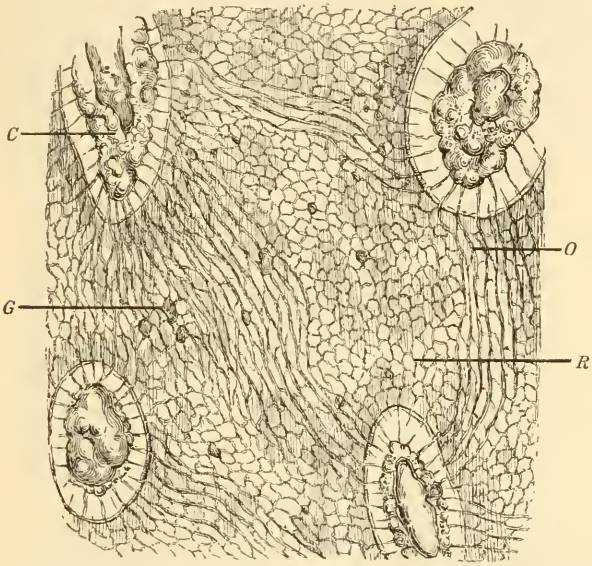

FIGURE 2.—Thyroid Cartilage of Adult, kept in strong Alcohol. Horizontal Section x 1200.

C. Shrivelled cartilage corpuscle.
O. Longitudinal off-shoots.
R. Reticulum in basis-substance.
G. Granules of living matter.

FIG. 2 shows offshoots from the cartilage corpuscles and the network in the basis-substance, with more or less large granules interwoven, as it were, in the network.

lage. After Johannes Müller had described cartilage-corpuscles that were hollow, and Gurlt had spoken of some as vesicles,—when Schwann had succeeded, as he thought, "in actually observing the proper wall of the cartilage corpuscles, first in the branchial cartilages of the frog's larvæ and subsequently also in the fish," he was led by these and other researches to conjecture "that the cellular formation might be a widely extended, perhaps a universal, principle for the formation of organic substances." And just as the study of cartilages has led to

the cell-doctrine, which at the time of its establishment was a great advance in biological science; so the further study of cartilage has supplied the basis for a generalization, which is a further development, and must take the place of the cell-doctrine. This is Heitzmann's doctrine of living matter, or, as I have named it, the *bioplasson-doctrine.*

When the term "cell" was introduced in 1838 and 1839, by Schleiden and Schwann, it was believed that, on ultimate morphological analysis, every plant and every animal would be found to consist of a number of minute vesicles or sacs, enclosing liquid contents in which is suspended a more solid body, the nucleus. For fully twenty years this idea has been known to be erroneous. In fact, Goodsir, nearly *forty* years ago—only a few years, that is, after Schwann had established the cell-doctrine and attributed the vital power to the cell-membrane, I say, nearly forty years ago Goodsir had experimentally determined that the seat of the vital process of secretion is not in the vesicle as such, but in the so-called cell contents; Naegeli, in 1845, and Alexander Braun, in 1851, had also shown the cell-wall to be comparatively unimportant; and in

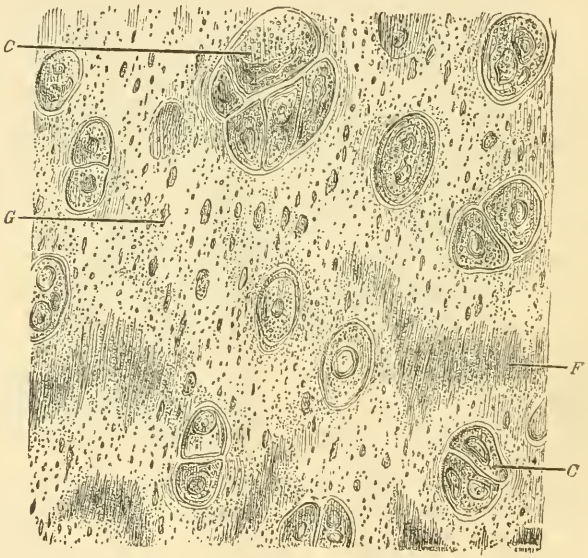

FIGURE 3.—Thyroid Cartilage of Adult. Horizontal Section x 600.

C. Cartilage corpuscle. F. Fibrous portion of cartilage. G. Granules of living matter.

FIG. 3 shows granules of various sizes in the basis-substance, with lower power of the microscope, which granules are seen with higher powers to be connected with the network of living matter, as shown by FIG. 4.

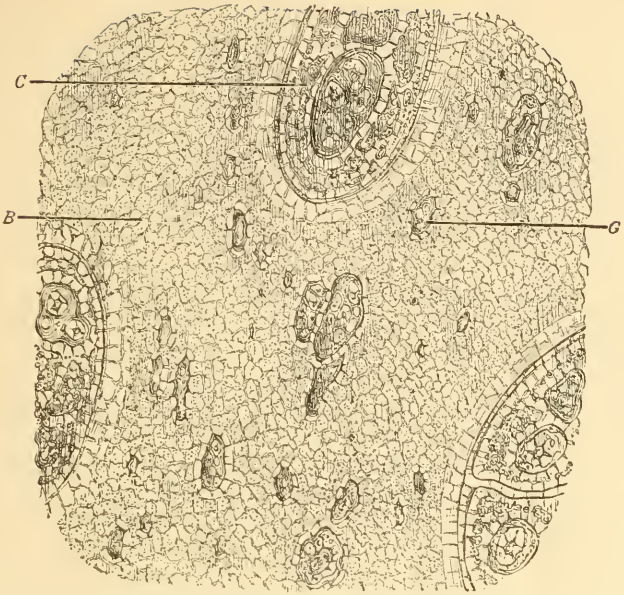

FIGURE 4.—Thyroid Cartilage of Adult. Horizontal Section x 1200.
C. Cartilage corpuscle. B. Hyaline basis-substance. G. Granules of living matter.

1857 Leydig had declared the "cell" to consist only of a soft substance enclosing a nucleus. Certainly, twenty years ago it was proved beyond dispute by Max Schultze, Beale, Hæckel, and others, that what was called a "cell" was not a vesicle, but essentially a jelly-like lump of living matter characterized by the presence of a nucleus; soon after, Robin, Brücke, Kühne, Stricker, and others, conclusively showed that not even a nucleus is an essential constituent of an elementary organism; and biologists were compelled to transfer the power of manifesting vital properties to "living matter," instead of restricting this power to any definite form-element. As long ago as in 1861, Brücke proposed to discontinue the use of the word "cell" as being a misnomer and misleading, and offered as a substitute the expression "elementary organism." Beale proposed, instead, the term "bioplast" to designate any definite mass of living matter, and Hæckel the term "plastid." From the latter I devised the word "plastidule," as synonymous with ultimate molecule of the substance of living matter. Elementary living matter is called with Dujardin "sarcode," or with Von Mohl "protoplasm," or with Beale "bioplasm," or, still better (because it is a designation etymologically more nearly meaning living, forming matter),

"bioplasson." Of these four synonymous terms, "protoplasm" is the one best known; but has been used in other senses, as well as to designate merely elementary living matter. I therefore think that "bioplasson" is to be preferred. Of course, *dead* bioplasson is a contradiction in terms: bioplasson deprived of vitality is no longer bioplasson at all, but merely the chemical remains of what *once was* bioplasson. If this be remembered, there will be no confusion, even if the word be used in describing tissues, etc., after death. According to Drysdale, Dr. John Fletcher of Edinburgh was the first, who clearly arrived at the conclusion that "it is only in virtue of a specially living matter, universally diffused and intimately interwoven with its texture, that any tissue or part possesses vitality."

As Fletcher's work was published in 1835, several years before even the establishment of the cell-doctrine, we cannot but agree so far with Drysdale as to say that Fletcher has framed a "hypothesis of the anatomical nature of the living matter which anticipates in a remarkable manner" its discovery! In 1850, Cohn[1] recognized the protoplasm "as the contractile element, and as what gives to the zoöspore the faculty of altering its figure, without any corresponding change in volume." He concludes that protoplasm "must be regarded as the prime seat of almost all vital activity, but especially of all the motile phenomena in the interior of the cell." In 1853, Huxley[2] said, "vitality, (the faculty, that is, of exhibiting definite cycles of change in form and composition), is a property inherent in certain kinds of matter." In 1856, Lord Osborne discovered carmine staining, and distinguished, by means of coloring it, the living formative matter from the formed material, a means which has borne important fruits in the discovery of Cohnheim's staining of living matter by gold chloride, and in that of Recklinghausen's staining all except living matter by silver nitrate.

In 1858, and in a number of later articles,[3] Max Schultze, by showing that, as had been hypothetically supposed by Unger, the movements of the pseudopodia and the granules are really produced by active contractile movements of the protoplasm, as well as by other observations, contributed much to the establishment of the theory of living matter. Hæckel has also for many years, and in various publications,[4] labored to

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[1] "Nachträge zur Naturgeschichte des Protococcus pluvialis." *Nova acta Acad. Leop.-Carol.*, vol. xxii, part i, p. 605.

[2] "Review of the Cell-theory." *British and Foreign Medico-chirurg. Review*, Oct., 1853.

[3] "Ueber innere Bewegungs-Erscheinungen bei Diatomeen," *Müller's Archiv*, 1858, p. 330; "Ueber Cornuspira," *Archiv f. Naturgesch.*, 1860, p. 287; "Ueber Muskelkörperchen und das was man eine Zelle zu nennen habe," *Reichert und Du Bois-Reymond's Archiv.*, 1861, p. 1; Das Protoplasma der Rhizopoden und der Pflanzenzellen, Leipzig, 1863.

[4] Monographie der Radiolarien, 1862, pp. 89, 116; "Ueber den Sarcodekörper der Rhizopoden," *Zeitsch. f. Wissensch. Zoölogie*, 1865, p. 342; Generelle Morphologie, vol. i, pp. 269, 289.

maintain and extend the same theory, of which he thus expresses himself,[1] "the protoplasm or sarcode theory, that is, the theory that this albuminous material is the original active substratum of all vital phenomena may, perhaps, be considered one of the greatest achievements of modern biology, and one of the richest in results." And, says Drysdale[2], "if the grand theory of the one true living matter was, as we have seen, hypothetically advanced by Fletcher, yet the merit of the discovery of the actual anatomical representation of it belongs to *Beale*, in accordance with the usual and right award of the title of discoverer to him alone who demonstrates truths by proof and fact. * * * The cardinal point in the theory of Dr. Beale is not the destruction of the completeness of the cell of Schwann as the elementary unit, for that was already accomplished by others, * * * but that, from the earliest visible speck of germ, up to the last moment of life, in every living thing, plant, animal, and protist, the attribute of life is restricted to one anatomical element alone, and this homogeneous and structureless; while all the rest of the infinite variety of structure and composition, solid and fluid, which make up living beings, is merely passive and lifeless formed material. This distinction into only two radically different kinds of matter, viz., the living or germinal matter and the formed or lifeless material, gives the clue whereby he clears up the confusion into which the cell-doctrine had fallen, and gives the point of departure for the theory of innate independent life of each part, which the cell-theory had aimed at, but failed to make good. The one true and only living matter—called by Beale germinal matter, or bioplasm—is described as 'always transparent and colorless, and as far as can be ascertained by examination with the highest powers, perfectly structureless; and it exhibits those same characters at every period of its existence.' * * *"

"The name of bioplasm," continues Drysdale, "given by Beale, or protoplasm, as indicating the ideal living matter, cannot be given to any substance displaying rigidity in any degree: nor to anything exhibiting a trace of structure to the finest microscope: nor to any liquid: nor to any substance capable of true solution. Thus 'nothing that lives is alive in every part,' but as long as any individual part or tissue is properly called living, it is only so in virtue of particles of the above-described protoplasm, freely distributed among, or interwoven with the textures so closely that there is scarcely any part, $\frac{1}{500}$ of an inch in size, but contains its portion of protoplasm. Thus we see realized the

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[1] Monographie der Moneren," *Jenaische Zeitschrift f. Medicin und Naturwissenschaft*, 1868, iv, 1; translation in *Quarterly Journal of Microscopical Science*, London, 1869, vol. ix, p. 223.

[2] *Loc. cit.*, 42, *et seq.*

hypothesis of Fletcher, that all living action is performed solely by virtue of portions of irritable or living matter interwoven with the otherwise dead textures." The objection, however, urged by Bastian to Beale is so very pertinent, that it must also find a place here, but I shall not dwell upon other points on which Beale differs from the bioplasson doctrine; such as, that living matter exhibits the same characters at every period of its existence; and that it is always perfectly structureless. "It has always appeared to me," says Bastian,[1] "to be a very fundamental objection to Beale's theory, that so many of the most characteristically vital phenomena of the higher animals should take place through the agency of tissues—muscle and nerve, for instance—by far the greater part of the bulk of which would, in accordance with Dr. Beale's view, have to be considered as *dead* and inert."

In 1873, the morphological knowledge of living matter became exact. In that year, Heitzmann discovered the manner in which bioplasson is arranged throughout the body, and announced the fact that what had until then been regarded as separate form-elements in a tissue are really interconnected portions of living matter; that not only are there contained no isolated unit-masses in any one tissue, but no tissue in the whole body is isolated from the other tissues; and that the only unconnected particles of living matter are the corpuscular elements of liquids, such as blood, sperm, saliva, pus, etc., and so-called wandering corpuscles; so that, to use his own words: "the animal body as a whole is a connected mass of protoplasma in which, in some part, are imbedded isolated protoplasma-corpuscles and various not-living substances (glue-giving and mucin-containing substances in the widest sense, also fat, pigment-granules, etc.)." This announcement marked the commencement of a new era in biology.

Heitzmann discovered that the living matter as seen in an amœba is *not without structure*, as had, before his accurate investigations, been supposed; and that its structure, in all cases when developed, is that of a network, in the meshes of which the bioplasson fluid, or the not-contractile, not-living portion of the organism, exists. When there is a nucleus, it is connected by delicate threads with the extra-nuclear network; nucleoli and nucleolini inside of the nucleus, as well as granules outside, are portions of living matter: sometimes in lump, sometimes mere points of intersection of the threads constituting the intra-nuclear and extra-nuclear living networks, sometimes terminals of section of such threads, as first explained by Eimer,[2] and after this author by

[1] The Beginnings of Life: being some account of the nature, modes of origin, and transformations of lower organisms. London, 1872, vol. i, p. 155.

[2] "Weitere Nachrichten über den Bau des Zellkerns." *Archiv f. mikrosk. Anatomie*, xiv, 1877, p. 103.

Klein.[1] Heitzmann discovered that what is true of the structure of bioplasson in the amœba, where a single small unit-mass of living matter constitutes the entire individual, is true also of the structure of bioplasson of all, even the highest, living organisms.

To be sure, much had been previously known regarding protoplasm or living matter, but the knowledge was fragmentary, until Heitzmann demonstrated not only that membrane, nucleus, nucleolus, granules, and threads are really the living contractile matter; but also, *first*, that this matter is arranged in a network, containing in its meshes the non-contractile matter, which is transformed into the various kinds of basis-substance, characterizing the different tissues of the body; and *secondly*, that the tissue masses of bioplasson throughout the whole body are interconnected by means of fine threads of the same living matter.

Unless these two facts of Heitzmann's discovery are accepted, there cannot be urged much against the continued use of the word "cell," misnomer though it be. Ranke,[2] after speaking of the "cell-wall," "cell-nucleus," etc., says: "of these component parts of the cell, one or other may be wanting without the totality ceasing to be a cell. The nucleoli, the cell-wall, or the nucleus may be wanting, and yet we must designate the microscopic form a cell, or elementary organism." Drysdale thus comments upon this quotation, viz.: "if any one choose to describe a gun-barrel as a stockless gun without a lock, he is free to do so; but what good purpose can it serve? Or is there even any fun in it? The truth is, this clinging to the mere name of the cell-theory by the Germans seems to arise from a kind of perverted idea of patriotism and of *pietas* toward Schwann and Schleiden." But I think Tyson[3] has the better of the argument, in saying: "the word "cell" has become so intimately associated with histology, that it is doubtful whether it will ever fall into disuse, nor does it much matter, so long as correct notions of the elementary part are obtained." Now, if there were any separate and distinct "elementary part," it certainly would matter little or nothing whether it were called "cell" or by any other name, provided the name be properly defined and agreed upon. It is not against the name but against the idea of any isolated individualized form-element that the objection lies. Virchow maintains, "that the cell is really the ultimate morphological unit in which there

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[1] "Observations on the Structure of Cells and Nuclei," *Quarterly Journal of Microscopical Science*, Jan., 1879, p. 128. "The intranuclear as well as the intracellular network having, of course three dimensions, includes fibrils that lie in the two dimensions of the plane of the field of the microscope, as well as fibrils placed vertically to it. The former appear, of course, as fibrils; but, I should like to ask, as what do the latter appear, *i. e.*, those situated vertically. Clearly as dots, because they are seen endwise; and for obvious reasons most of them lie in the nodes of the network."

[2] The Cell-Doctrine; its history and present state. Philadelphia, 1878, p. 128.

[3] "Physiologie, 1872," quoted by Drysdale, *loc. cit.*, p. 104.

is any manifestation of life, and that we must not transfer the seat of real action to any point beyond the cell."[1] Against this statement nearly every author nowadays protests, and insists that vital power must be transferred from the "cell" to "living matter"; yet, after all, the disagreement, though ever so strenuously declared, is a mere verbal one: so long as both parties hold that "every higher animal presents itself as a sum of vital unities"—no matter what these unities are called or how defined. Hæckel, one of the most avowed advocates of "the protoplasm or sarcode theory," clings to Virchow's politico-physiological comparison, that every higher organism is like an organized social community or state, in which the individual citizens are represented by the "cells," no matter how he may define these, each having a certain morphological and physiological autonomy, although on the other hand interdependent and subject to the laws of the whole. Heitzmann's views necessitate the comparison of the body to a machine, such as a watch or a steam-engine, in which, though there are single parts, no part is at all autonomous, but all combine to make up one individual. Even Huxley, the popular champion of protoplasm as the physical basis of life, quite recently delivered an address, before the International Medical Congress in London, August 9, 1881, in which he used the following language: "in fact, the body is a machine of the nature of an army, not of that of a watch, or of a hydraulic apparatus. Of this army, each cell is a soldier," etc., etc. According to Hæckel and Huxley, the body is composed of colonies of amœbæ; according to Heitzmann the body is one complex amœba. I am very anxious to really make the difference between the cell theory and the bioplasson theory clear to every one of you. The essential point of the cell theory is the idea, that the body and each tissue of the body, every plant, and every animal, is made up of a number of distinct units; and the essential point of the bioplasson theory is the idea, that all the masses of living matter of each tissue of plants and animals are uninterruptedly connected, and that every tissue is connected with every other tissue by filaments of living matter. To accept Mr. Huxley's comparison, we must imagine that every soldier is indissolubly connected, hand and foot, with every neighboring soldier of the solid army!

There is no better test of the truth of the bioplasson doctrine than the structure of hyaline cartilage. If hyaline cartilage consisted, as "is generally believed," of "a homogeneous ground substance, in which are closed cavities harboring the corpuscles," the bioplasson doctrine would certainly be erroneous. If it merely contained lymph, or juice-channels, no matter what their character, whether open or

[1] Die Cellularpathologie in ihrer Begründung auf physiologische und pathologische Gewebelehre, Berlin, 1858, p. 3. (Translation by Chance, London, 1859, p. 3).

closed, whether lined or unlined, whether in "homogeneous basis-substance," or "between layers of cells," or "in cement-substance,"[1] then, too, the bioplasson doctrine would be erroneous.

But the result of my observations, especially those illustrated in figs. 2, 3, and 4, admit of but one interpretation, and that an interpretation favorable to the bioplasson doctrine. It is unnecessary to more than mention that although I have placed on record so few, I have made many different examinations, under many different circumstances, and with varying powers of amplification. I need occupy myself here with only the two fields drawn in figs. 3 and 4, with an amplification of 600 and 1200 respectively. The remarkable specimens from which they are taken show more conclusively than it was ever before shown what the structure or constitution of hyaline cartilage really is. I think I have explained this sufficiently, but its full significance appears in its corroboration of the bioplasson doctrine.

To be able to uphold the cell-doctrine, cartilage would have to be, using a homely comparison, like a cake composed of hard dough with raisins. No matter how widely we may extend the definition, to remain within the boundary of the cell-doctrine this metaphor must be applicable. Innumerable painstaking researches have led to various modifications of notions entertained regarding the structure of the two constituents of the cake and their relation to each other. It may be seen by the most recent publications on the subject, that the acceptation of the existence in the dough of cleavage in certain directions, of interlaminary and interfibrillar spaces, and of offshoots, even ramifying prolongations of the raisin-substance, or, at all events, of an ingredient of the raisins, is held to be not incompatible with the cell-doctrine. If, however, we can represent cartilage as a filigree or framework of raisin-substance, in the meshes or interspaces of which framework blocks of dough are imbedded, certainly the fundamental view of the ultimate construction of the tissue is changed, and we are no longer in accord with the cell-doctrine, even though we be inclined to use that term in the widest possible sense. Look for a moment at the two illustrations on the blackboard, as well as at figs. 2, 3, and 4. The upper figure represents a section of cartilage stained with gold chloride.

This, as I have already explained, stains the living matter and leaves the basis-substance unstained. High powers exhibit the appearance, etc., etc. In regard to a name as a substitute for the term "cell," I would say that all corpuscular masses may be called, simply, corpuscles

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[1] These statements of the general belief are quoted from the introductory paragraph of Thin's memoir, "On the Structure of Hyaline Cartilage" (*Quarterly Journal of Microscopical Science*, xvi, 1876), in which Thin's own views are laid down to the effect "that layers of cells epithelial in arrangement exist in the substance of cartilage," "that both the stellate and the parallel systems of lymph-channels exist," etc.

—thus we may speak of blood-corpuscles, pus-corpuscles, etc. For all the accumulations of living matter within the ordinary fields of basis-substance, but more especially for those smaller masses which, having as yet developed neither a network structure nor much vacuolation, are still homogeneous, or nearly so, I am quite willing to adopt either the designation of "plastids," proposed by Hæckel, or that of "bioplasts," proposed by Beale. Perhaps it would be well to restrict the word "bioplast" to a small mass of living matter exhibiting no differentiation, and distinguish from it as "plastid" the larger mass showing an interior structure more or less like the fully developed corpuscle. Thus, I would always use the term "plastid" in the place of "cell."

The result of my investigations as to the structure of cartilage is that in this tissue, beyond the possibility of a doubt, the living matter is arranged in the form of a network, containing in its meshes the non-contractile matter. How is it with regard to the other proposition of the bioplasson doctrine, viz., that the living matter of the different tissues is interconnected? Examinations with high powers of such a specimen as that represented in fig. 1, showing the perichondrium of horizontal sections through the larynx, or the neck, with skin and more or less of other tissues included, enable me to answer this question to the effect that fine filaments of living matter pass from one tissue to another in connection with the network of living matter in each. The details of these examinations are reserved for another time. But it has been suggested to me that I ought not to conclude without saying a few words as to the practical advantages of the Bioplasson Doctrine over the Cell-Doctrine. Every exact scientific investigation, even though at first of theoretical value only, sooner or later brings with it some practical benefit; and this doctrine of living matter, aside from the satisfaction which the perception of abstract truth grants—lying as it does at the foundation of our knowledge of living things—has advanced their physiology and pathology at every point. In practical medicine it has already aided us in so many ways that their merest enumeration would require another hour's lecture. We know that the disposition of living matter is different in different persons, and that in the case of increased supply of food the reaction is different in strong and healthy people from that in the sick and weak. Upon this knowledge rests, to-day, the *whole doctrine of pulmonary consumption.* Now, the amount of living matter within the same bulk varies greatly both in normal and morbid conditions. A small lump of bioplasson in the urine or expectoration, taken from an individual of good constitution, will show a close network with coarse granulations, or perhaps be almost homogeneous-looking under the microscope—owing to the large amount of living matter in the small bulk: while a plastid, from a

weak, broken down or phthisical person, will be finely granular and exhibit a network with large meshes on account of the relatively small amount of living matter in it. Sometimes we thus, from the examination of a drop of blood, gain an insight into the condition and vital power of the whole individual; sometimes, recognize a disease before it is sufficiently developed to do much harm, and thus come a step nearer to the highest aim of the physician—the prevention of disease.

DISCUSSION.

Dr. B. N. MARTIN remarked on the great value and important bearing of this investigation.

Mr. A. H. ELLIOTT enquired whether the blocks of non-living matter in the cartilage were entirely separated.

Dr. ELSBERG explained that the blocks were separate, their only connection being the interposed threads of the *reticulum* of living matter; and to the former is due the opalescent character of hyaline cartilage. He further stated that the condition of health of an individual might be inferred in a degree from a study of the character of the network, a thin section of a very minute portion of the body often showing a difference of network in different persons, *e. g.*, in the thickness of the threads, the size of the meshes, the character of the points of intersection, etc. From the uniformity in the size of the meshes, etc., or from their variability, or from the proportion of corpuscles presenting a normal and abnormal character in their network, a good or bad prognosis was deduced by the physician, and even an indication of the progress of disease.

Prof. E. H. DAY referred to the wonderful character of protoplasm in its wide results in the construction of the most varying textures in the vegetable and animal kingdoms. The speaker's observations have brought the protoplasm of cartilage tissue into correspondence with that in the tissues of the sponge, of the plant, and all the lower forms of life. In protoplasm we are brought face to face with the most astonishing substance in nature.

Mr. J. D. WARNER offered objections to the vague views of Virchow on the soul of the cell and its relation to the soul of the individual.

Dr. NEWBERRY said that, having been educated as a physician, and having studied microscopic anatomy under Dr. Charles Robin, he had followed with great interest the progress of modern research into the ultimate structure of organic tissue, and the discussions of the origin and seat of vitality to which it has given rise; and he regarded such investigations as those of Dr. Elsberg as of the highest scientific interest and practical value. If we ever learn the causes of malarial and infectious diseases, or the cure of the morbid growths which are

the scourges of humanity, cancer and tubercle, it will be through such researches. But he thought that much of the discussion which had been excited by these investigations had been irrelevant and confusing, especially that in regard to the seat and nature of life, into which microscopists and chemists had entered with great earnestness and some acrimony, but with no satisfactory result. In this discussion some writers had made the ultimate cell the seat of life, and had glorified and almost deified it. Others claimed that the cells were only portions of a general vitalized and automatic tissue; while others still contended that the phenomena of vitality were the mere manifestations of chemical changes taking place in structure otherwise lifeless.

With none of these views could he sympathize, as there had really been no approach to an end in the effort to localize or analyze life. Unless we accept the materialistic theory of spontaneous generation, advocated by Dr. Bastian, but rejected by most biologists, we must confess that no more is now known of the origin, nature and seat of life than was known to Aristotle. All we have done is to acquire a better knowledge of the *machinery* by which the functions of life are accomplished; most important knowledge truly, since it enables us to distinguish between normal and morbid life action in the tissues where this action begins, and promises to point the way for promoting the one, and preventing the other—but limited to the methods in which the life force acts, not reaching the inscrutable and intangible force itself.

The work done by a microscopic cell is wonderful and incomprehensible to us, yet all cells work not as independent individuals, but as members of a community, and for a common end. For example, the terminal cell of the fibril of a plant root is a delicate vesicle—the cell in its simplest form, and yet when new born, and having existed but the fraction of a minute, it begins its special work of supplying certain food elements to the plant above; and this it does with a discrimination which is infallible. Water it absorbs by endosmosis, and, when deficient, begets progeny to send for it. It also appropriates other things that are necessary to the growth of the plant to which it belongs, whatever that be; if tobacco, an unusual quantity of potash; if grass, of silica. It always works to a pattern determined by the character of the plant whose general economy it serves, and is controlled by the influence which gives to that plant its special and recognizable leaf, flower and fruit, its noxious or alimentary qualities. So in all other parts of the structure the cell is doing its allotted work in a community of which it forms an integral part. It is therefore in no sense an independent individual. Our notions of what constitutes an individual or a community may seem to us quite clear, but they are in fact likely to be somewhat confused. Every man recognizes and asserts his own individuality, but

we all know that men who live in communities often think and feel as one though many. A great grief crushes all alike, a great danger rallies all in defence. The social insects, ants and bees, retain their corporeal individuality, but are curiously linked together in a common life that makes each but a part of a whole. A tree is universally accepted as an individual, but, as all know, it may be divided to form an unlimited number of perfect trees which expand this individual into a forest and prolong its life indefinitely. The sponge is said to be a community of amœboid individuals, but these share a common skeleton, fashioned for the wants of all, and all unite in the general function by which the inhalent and exhalent currents are maintained, a function on which the life of all depends. In the corals which live in communities, we find the common skeleton covered with a vitalized gelatinous integument on which are set here and there the individual polyps. These live to a great degree each for itself; each throws out its tentacles and forages for its own support, but at the same time it shares a life with its neighbors; an injury done to one affects those about it, and a misfortune involving a sufficient number destroys the life of the colony.

The elusive and intangible nature of the life which pervades plant tissue is well shown in the growth and decay of a tree. From a microscopic germ a young *Sequoia* springs into existence, and for a thousand years or more lives its life. All this time it is inspired by a power which acts in antagonism to the affinities of inorganic chemistry in opposition to the force of gravitation, and which builds up a mass hundreds of tons in weight, mostly obtained by the breaking up of one of the strongest bonds in chemistry, that of carbonic acid, appropriating the carbon and setting the oxygen free. Every part of the huge structure is pervaded by this peculiar creative and conservative influence; and every cell of root or stem or leaf contributes its part to the harmonious whole. At length the time arrives when this peculiar influence which we call life deserts the structure it has created. The affinities of inorganic chemistry now assert themselves, all the ephemeral fabric is rapidly disorganized, and soon a heap of ashes—the inorganic matter woven into its composition—alone remains to tell of its existence. Who can tell us what was the nature of the enchantment which created this Aladdin's palace—whence it came, where it dwelt during its sojourn, and whither it has gone? We may say it resided in the terminal root cells; but these are inseparably connected with the leaves, hundreds of feet above. The tie that binds them is a vital one; neither could live without the other, nor without the intervening chain which connects them.

By studying the anatomy of plants and animals, we obtain a knowledge of the organs and laws, as we call them, of animal and plant life;

that is, we get a knowledge of the machinery with which the functions of life are accomplished, a knowledge of the order and manner in which these functions are performed; but the *primum mobile*, the real "power behind the throne," remains as yet unseen and unknown to us.

November 28, 1881.

LECTURE EVENING.

The President, Dr. J. S. NEWBERRY, in the Chair.

The hall was filled to overflowing.

In introducing the lecturer of the evening, the President stated:

'Captain Cheyne asks you to examine his plans carefully. He has been with three expeditions to the Arctic regions, and has spent there five and a half years. He has been there under so many circumstances that he knows, perhaps better than any other man, the difficulties to be encountered and how to overcome them. He comes recommended by the highest authorities in England. His plan is not chimerical, and it is certainly heroic. Men will yet surely go to the Pole, if they have to crawl there on their hands and knees; and an enterprise of this kind is worthy of attention in these days, if only to withdraw the minds of men from their shops and money-getting and purely selfish occupations."

COMMANDER JOHN P. CHEYNE, R. N., F. R. G. S, then delivered the following lecture:

THE DISCOVERY OF THE NORTH POLE PRACTICABLE.

(Abstract.)

Reference was first made to the large number of local committees—sixty-two—and of influential persons in England who have signified their approval of this enterprise.

A Council has been formed in England and is now awaiting the news from America. As soon as it has heard of action taken here toward the formation of an Anglo-American expedition, the members of the Council will bestir themselves. It was originally designed, by means of an expedition, the cost of which would have been about £30,000, to include the circumnavigation of Greenland, besides the journey to the North Pole.

The following plan is proposed for reaching the Pole. A small vessel will be engaged to convey the exploring party, with provisions for two years and a half, to St. Patrick's Bay, near Discovery Harbor, leave them there, and immediately return. The party will consist of

seventeen persons all told, including Lieut. Schwatka, U. S. A., the commander of the late American Franklin search expedition, who has most cordially volunteered to accompany this party, on the part of America.

To attempt to reach the Pole in the usual manner, there would be required six sledging parties of five men each. Each man would have to drag 215 pounds. The Lecturer believed that the journey could be performed by means of sledges, as he had not the most remote idea that there is an open sea about the Pole. Starting in April or early May with the six sledges, they would go fifty or sixty miles on the journey; and then sledge No. 6 would stop and bury in some safe place all its spare supplies, as a depot for the return journey, and that sledge would return to the ship. After going fifty or sixty miles more, the fifth sledge would stop in the same way, bury its spare provisions, and return to the ship. The first sledge would keep on until the Pole was reached. In this way the journey might be made in 106 days, but would be far more difficult and laborious than that proposed by the following plan.

On arrival at St. Patrick's Bay, three snow observatories will be established, one situated in the immediate vicinity of the coal mine, at St. Patrick's Bay, another fifty miles further north, and the third the same distance to the south. These observatories will be connected by telegraph wires, and hourly meteorological observations will be taken and transmitted to the central station. Thus accurate information as to the direction and force of the wind, simultaneously over a distance of one hundred miles, will be obtained and immediately plotted at the central station. When the proper wind curve for reaching the Pole is found to exist, the attempt will be made by means of balloons. These will be of large size, and three in number, costing altogether about £12,000. Each will carry three men, be provided with a boat car, a set of Esquimaux dogs, and provisions for fifty-one days. The total load for each balloon will be between one and one-half and two tons. The gas for inflating the balloons will be generated, at least mainly, from the abundant coal at this harbor, and, to prevent the too rapid diffusion and loss of gas, it is proposed to employ a double envelope of silk with an intermediate layer of gold-beaters' skin. It has not yet been decided whether to use pure hydrogen or a mixture of coal gas and hydrogen. The Commander has convinced himself by experiments with balloons, both in polar regions and in England, that they can be satisfactorily used in the way above proposed; and he hopes to cover the distance from St. Patrick's Bay to the Pole, 496 miles, in from eighteen to twenty-four hours. The altitude of the balloons will be regulated at about one thousand feet by means of a trail rope.

After arrival at the Pole, advantage will be taken of a favorable wind to return to St. Patrick's Bay, or, possibly, to continue in one balloon right on to some part of Russia, should it appear better to take that course. Any loss of gas during the balloon trip, which may be found to have occasioned a deficiency on arrival at the Pole, or during a short stay there for scientific observations, may be remedied by the abandonment of one balloon and the transference of its gas into the other two, and, possibly, by the conveyance of a small supply of hydrogen in steel cylinders.

Many interesting arctic phenomena were discussed: *e. g.*, the proofs that the aurora borealis was not caused by atmospheric electricity but by magnetism: the numerous parhelia and mock moons visible in polar regions: the mode of formation of glaciers and icebergs, and the curious shapes assumed by the latter.

The coal of the mine at St. Patrick's Bay was described as equal to the best Welsh, almost smokeless, and existing in very large quantities. The present meagre flora of Greenland was compared with the rich ancient flora, almost tropical in character, shown by the fossil plants found in the Tertiary beds of the vicinity of Disco. More than fifty species of trees and shrubs have been obtained from these deposits.

In conclusion, the Lecturer spoke of the very probable success of the proposed Anglo-American expedition now being organized by Lieut. Schwatka and himself, and stated that the estimated expense, at a minimum, is to be £16,000, each country to provide half of this sum, and all discoveries to be equally shared by the two nations. The Commander laid great stress upon the good feeling existing between America and England, expressing the opinion that the organization of such a joint expedition as proposed, especially if the two national flags were to be planted side by side at the world's apex, would so materially develop that feeling, that therein would be at once an answer to those questioners who asked "*cui bono*? What commercial return can we expect for our expenditure for equipment?" Further utilitarian achievements were then touched upon, as relating to the more thorough study of the sea-bottom by soundings, and of the oceanic currents within the Arctic circle, so that in time commerce will be enabled to work out more definite highways for the passage of ships across the ocean; also to the development of knowledge in different branches of science, in addition to the advantages that might accrue in opening up and investigating such a vast unknown area.

At the conclusion of the lecture, the audience expressed, by a show of hands, its hearty interest in the subject, after the delightful mode of its presentation and illustration by Commander Cheyne, and its recommendation of the matter to the careful consideration of the public.

Dec. 5, 1881.

REGULAR BUSINESS MEETING.

The President, Dr. J. S. NEWBERRY, in the Chair.

Twenty six persons present.

Dr. NEWBERRY exhibited an ancient perforated stone axe from Europe, consisting of dioryte, and remarked that the aboriginal tribes of America never attained to the degree of skill required in the perforation of stone implements for the insertion of wooden handles.

The following paper was read by Dr. ALEXIS A. JULIEN.

THE VOLCANIC TUFFS OF CHALLIS, IDAHO, AND OTHER WESTERN LOCALITIES.

(*Abstract*).

In a paper recently read before the Academy it was shown that a certain compact white almost structureless rock, often porcellanous in texture, occuring abundantly in the Western Territories, and variously styled "trachyte," "rhyolyte," "porphyry," etc., (*e. g.*, at Leadville, Colorado, in the Black Hills of Dakota, etc.), is a sedimentary form of a highly silicious volcanic tuff, probably derived from the finest detritus of trachytes, rhyolytes, and quartz-porphyries. A series of specimens collected by Prof. NEWBERRY, during the last and previous summers, and kindly put in the author's hands for lithological examination, has furnished the material for the following additional notes on this interesting but neglected group of widespread American rocks.

1. *Coarse pumice-tuff of Challis, Idaho.*

The rock is quite compact, schistose, of a gray color with dull white spots. The latter consist of pumice in finely fibrous grains, from 1 to 5 mm. in length. Quartz and feldspar are seen in small angular flakes, sometimes reaching 0.5 mm. in length: hornblende commonly in fibrous black fragments, about 1 mm. in diameter: and much biotite, brownish-green, sometimes brownish-black, with greasy lustre, in hexagonal scales, often up to 2 to 3 mm. in size.

The thin sections present under the microscope numerous grains, generally angular, of several minerals, varying in size up to 3 or 4 mm.: pumice in rounded to sub-angular fawn-colored fragments lying at all angles, commonly made up of straight or curved fibres, and often including glassy lenses filled with crystallites: a triclinic feldspar, in clear grains, sometimes including minute globules of glass, and possessing fine lamellation, beautifully striated in polarized light, the remaining traces of crystalline outlines indicating that these grains are all of fragmentary, never of indigenous formation: quartz, in water-clear angular

grains, 0.2 to 1.6 mm. long, retaining more frequent and perfect traces of their crystalline forms, their sides being often very ragged, curiously and deeply eroded into rounded indentations, while within occur numerous inclusions of the ground-mass and of scales of biotite, long greenish needles of hornblende, and sub-angular drops of a brownish-violet glass with one or several fixed bubbles of gas: biotite in abundant irregular scales, 0.2 to 1.3 mm. long, brown inclining to maroon or brownish-yellow, cloudy to opaque, with some dichroism remaining in the striated sections; hornblende in brownish-green, strongly dichroic, fibrous crystalline flakes: opacite, probably magnetite, and ferrite or iron-oxide, in dusty particles or groups in the biotite scales and among the pumice fibres. The fine ground-mass is mainly composed of minute fragments, fibres, scales, etc., of all these minerals: also in large part of solid globules of fawn-colored glass, or of thin and apparently hollow shells, or of fragments of quartz or feldspar coated with a glass crust. Many of these forms are found adhering in curious aggregations or with their sides crushed in.

The general constitution of this rock is similar to that of the volcanic tuff of the El Dorado Cañon, Cal.

2. *Fine green volcanic tuff, of Challis, Idaho.*

A very fine compact rock, with almost the texture of stoneware, with a pale, greenish-gray color, and a very thin parallel lamination. A few minute scales of biotite can be distinguished by the loup. The surfaces of fissures are mottled and spotted with bluish-green and ochreous, brownish-gray films.

The thin sections present the same constitution as that of the coarse variety of the rock, without the presence of pumice, the particles of quartz and feldspar varying in size from 0.06 to 0.25 mm. Biotite is abundant in scales 0.1 to 0.2 mm. in diameter, often of ochreous shades of brownish-yellow and maroon, through partial decomposition, and with curved fibres or wrinkles as if crushed in by pressure. To its abundance are due the fine lamination of the rock and, in part, its greenish color. The ground-mass largely consists of globules of colorless glass, but in less degree than in the preceding variety, their size varying from 0.006 to 0.01 mm.

3. *Fine white pumice-tuff, of Challis, Idaho.*

A very fine compact rock, grayish, with a bronze shade, with a lamination so decided that it inclines to slaty. Under the loup the same constituents are visible as in No. 1.

The thin sections show a close relationship to those of No. 2. A little hornblende is present. Biotite occurs in distinct scales, sometimes hexagonal, not so minutely dispersed as in No. 2, generally 0.01 to 0.1 mm. in diameter. The fragments of quartz and feldspar, as a rule,

present their longer axes in the schist-plane, varying from 0.03 to 0.22 mm. in length. The glass inclusions in the quartz, range from 0.002 to 0.037 mm. The ground-mass appears to be mainly composed of pumice, more or less altered, in very minute fibres and particles.

This rock strongly resembles the tufa of the lignite beds near Osarisawa, Akita, Japan.

4. *Pumice-tuff, Moore Station, Pancake Range, Moray, Nevada.*

This rock is decidedly schistose, cream-colored, nearly white, of a fine grain, intermediate between Nos. 1 and 2, most of the constituents being the same as in No. 1 and less than 0.5 mm. in diameter, though occasional grains of pumice, gray and red obsidian, and perfect crystals of quartz, may reach from 2 to 8 mm. in length.

In the thin section the constituents are found disposed with great regularity: pumice, with its fibres often curved, as if crushed while still soft and plastic: quartz: triclinic feldspar, possibly sanidine: magnetite: ferrite: biotite, salmon-colored, sometimes very cloudy: and volcanic glass in cellular network, often full of gas bubbles, elongated and distorted. In the ground-mass, globules of glass and fibres and threads of pumice largely predominate.

The pumice in all these tuffs is not perfectly isotrope between the crossed nicols, but presents innumerable, though exceedingly minute glittering points, apparently crystallites formed by incipient devitrification. A few minute sphærulites were also detected.

5. *Stratified Rhyolye-tuff, Tempiute, Nevada.*

A snow-white kaolinic variety, related to the preceding, which appears to consist principally of pumice. A few grains of black obsidian and red quartzite occur, the latter also as a somewhat rounded pebble, 34 mm. in length.

The thin section, transverse to the schist-plane, presents an interesting structure, made up of granular layers alternating with others possessing strong fibration.

The material of the former is mostly like that of No. 4: feldspar is sparsely scattered: quartz fragments abound, with the usual glass inclusions, and with sides deeply eroded and indented: also magnetite, ferrite, and minute colorless particles of a polarising mineral, perhaps Augite, in a predominant ground-mass of particles and fibres of pumice and glass, rich in dark gas-bubbles.

The alternating fibrous laminæ consist of a true rhyolyte material, salmon-brown, with a marked fluidal structure around the few quartz-grains, and displaying in spots, and especially next the junction with granular material, the constituent pumice-fibres whose partial interfusion or cohesion seems ordinarily to have produced the solid laminæ.

The arrangement of the glass fibres in parallel planes may have been

produced by sorting in the air during their fall, or by later superincumbent pressure while still hot and plastic, or it may be in some instances by the influence of overflowing lava-sheets. The cohesion produced by such downward pressure and interfusion has produced a structure which can hardly be distinguished from that of many obsidians and rhyolytes.

6. *Fine white pumice-tuff, from mouth of Bill Williams' fork of Colorado River, Arizona.*

A compact white schist, with almost the fine texture of No. 3, traversed in places by brown curved impressions, apparently produced by rootlets.

The thin section mainly exhibits a very finely felted mass of short, straight fibres of pale brownish pumice. Besides these only a very few black particles of magnetite, feldspar, etc., were distinguished.

7. *Fine brownish pumice-tuff, from last locality.*

A brownish variety of the preceding, with abundant minute black particles. The slaty lamination is decidedly marked, with slight adherence over many planes at which the rock breaks easily, presenting remarkably flat surfaces.

The constitution displayed in the thin section is similar to that of the preceding specimen. Minute glass globules are abundant, and also more numerous angular particles of other minerals: colorless feldspar (sanidine?) showing cleavage: brownish and greenish augite: brownish and dichroic fibres of hornblende, and black particles of magnetite.

8. *Stratified pumice-tuff, from Black Mountains, Colorado river, Arizona.*

A coarser stratified tuff with brown and white layers, in which grains of pumice, obsidian, glassy feldspar, and quartz reach a diameter of 1 to 5 mm.

The thin section is rich in pumice in all its fibrous, curving, and reticulated forms, and in minute globules, threads, and shreds of volcanic glass: angular grains of finely lamellated plagioclase, water-clear quartz, and sanidine with well marked cleavage and often zonal structure: particles of biotite, hornblende, magnetite and ferrite: abundant grains of augite, angular to rounded, sometimes retaining its optical characteristics in spots, but mostly decomposed and isotrope, colorless, brownish-yellow, light to deep maroon, etc., finely granular, thready, or fibrous, and more or less darkened by opacite even to complete opacity.

9. *Basalt-tuff, or peperino, Chinati Mts., Texas.*

A fine-grained olive-green rock, with white streak, friable to arenaceous, with barely perceptible schist structure in the specimen. Under the loup, minute granules of feldspar, quartz, etc., are distinguishable, rarely 1 mm. in diameter, embedded in a grayish-green cement.

In the thin section the constituents are very much the same as in No. 8, with the exception of hornblende, and all the grains are in large part rounded. A few elongated rounded grains of a basaltic lava are also included, highly microcrystalline with minute ledge of plagioclase scattered through a reddish-brown opaque base.

This specimen, and perhaps the preceding, represent the basic division of the tuffs, being ejections from an eruption of basaltic lava, though naturally composed of its more fluid, glassy, and acid scoria.

From these facts it may be concluded that enormous masses of volcanic tuffs of widely varying character are dispersed throughout these regions in the West, to an extent which could hardly be appreciated from the meagre references in our present petrographical literature.

In his discussion of the rhyolytes of the fortieth parallel, Zirkel remarks :*

"The foregoing descriptions show in what abundance those fibrous bodies in which the fibres are not grouped radially around a centre, as in sphærulites, but arranged axially along a longitudinal line, are disseminated through these rhyolites .... These axiolites usually consist of distinct, uniformly thin fibres, or of wedge-like particles.... We see in the arrangement of the fibres in these rhyolites four different types : *a*, centrally radial : *b*, longitudinally axial : *c*, parallel : *d*, confused and orderless. The development of fibres is, indeed, a phenomenon very characteristic of rhyolites, etc., etc."

A comparison of these facts with those presented in my examination of these tuffs, appears to me significant, not of the development of fibration, etc., in a fused mass, but of the fragmental origin of at least many rhyolytes, obsidians, etc., as suggested in the study of No. 5. The evidences of the hot and plastic condition of the fibres and drops of volcanic glass, with the occasional exception of a cooled outer shell, for a long time after their fall, and of a tendency to the growth of microliths, sphærulites, etc., within them, may offer another mode of origin for the formation of axiolites and sphærulites. The anomalous presence of augite in a quartzose rock like rhyolyte, to which Zirkel calls attention in the same passage, may also find explanation in the varied intermixture of minerals which prevails in many tuffs, rather than by indigenous development within an acid lava.

Dr. NEWBERRY said that he had no doubt that Mr. Julien was quite correct in regard to the genesis of the peculiar rocks which he had described. He had collected the specimens and was able to supply some facts in regard to their mode of occurrence. They belong to a series of rocks, plainly volcanic, but of which the history has not been given by those who have studied the volcanic rocks of the West. The circumstances of their occurrence are briefly these : over a great belt not less than one thousand miles wide in some places, viz., from the

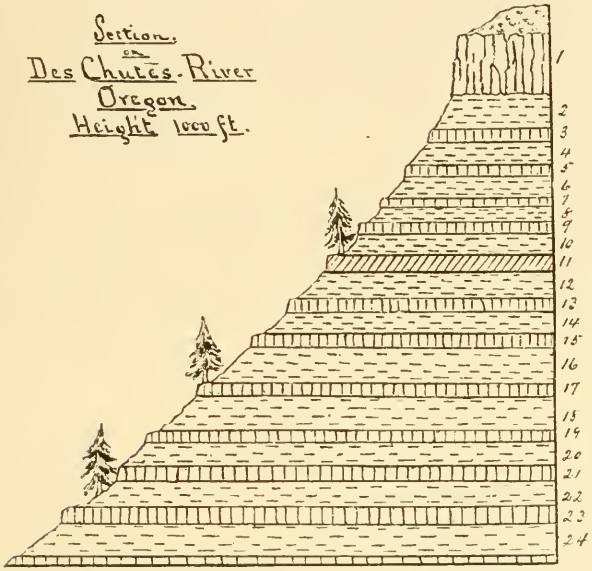
* U. S. Geol. Expl. 40th Par., VI, Microsc. Petrog., pp. 201-205.

crest of the Sierra Nevada to the eastern foothills of the Rocky Mts., and with a north and south extension of thousands of miles in British Columbia, the United States and Mexico, we have an extraordinary display of the products of volcanic action. This is the great silver belt of the world, and is also rich in mines of gold, copper, lead, etc. Throughout all the Paleozoic and Mesozoic ages this country was an unbroken, though not entirely unwarped, sub-marine or sub-aerial plateau, where the most continuous and extensive series of sedimentary rocks was deposited of which we have any knowledge. At the close of the Jurassic age the western portion of this region was folded up, to form the great chain of the Sierra Nevada and Cascade Mts., and along this line of fracture numerous volcanic vents were established, Lassen's Butte, Mt. Shasta, Mt. Hood, Mt. Baker, etc., which have continued in intermittent activity to the present day. In Tertiary times the plateau east of the Sierra Nevada was broken up by a series of north and south fractures, resulting in the formation of the remarkable system of meridional mountain ranges which constitute the chief topographical features of the district. These mountain ranges are composed of blocks of Paleozoic limestones and sandstones—now converted into marbles and quartzites—set up on edge or at a high angle,—or of volcanic materials which have welled up through some of the fissures. Along the lines of fractures are great numbers of hot springs, the representatives of thousands more which existed in former days, and to which we owe the great system of fissure veins of this country :—hot water charged with mineral matter gradually depositing this and filling the channels through which it flowed.

The volcanic rocks which have been poured out in so many places exhibit a great variety of physical and chemical characters, but have been grouped by RICHTHOFEN and ZIRKEL into five species—propylite, rhyolite, trachyte, andesite and basalt. Capt. DUTTON, who has given great attention to the volcanic rocks of the West, has distinguished a larger number of kinds and has adopted a different classification. Aside from these massive rocks there is another group which constitutes a marked feature both in the topography and geology, and these are those which have been made the subject of Mr. JULIEN'S paper. They are generally soft in composition, often highly colored,—white, red, blue, green, gray or yellow—more commonly white, red or gray. They are often quite local and usually occupy the lowlands, frequently underlying much of the level surface between the mountain ranges; and their best exposures are seen in the banks of streams which have cut these lowlands. There they are shown to be often horizontally bedded and sometimes interstratified with lacustrine sediments and sheets of basalt. Typical exposures of these rocks may be seen

at Eureka, Nevada, where houses and cellars are excavated in the soft material which forms the sides of the valley; at Challis, in the banks of Salmon River and Garden Creek, whence the specimens described by Mr. JULIEN came, and in the cañons of the Des Chutes and its tributaries in Oregon.

Economically these rocks have considerable importance, as they are extensively used in place of fire-brick for lining lead-smelting furnaces, being very refractory, and easily dressed into shape with an old axe.



The above section represents the filling of some of the fresh water lakes which formerly existed in Oregon just east of the great volcanic cones of the Cascade Mountains. Numbers 1 and 11 represent sheets of basalt, the even numbers softer tuffs and bed of diatomaceous earth, the odd numbers consolidated conglomerates of volcanic materials called "concrete" in my notes.

The study of a large number of outcrops of this series of rocks from Southern Arizona to the Columbia River, has convinced me that they are generally volcanic ashes which have been washed down and more or less perfectly stratified in bodies of water which formerly occupied the intervals between the mountain ranges of the great basin. On the Des Chutes a section of more than 1000 feet shows 25 alternations of strata, many of which are examples of the rocks in question. Here they are interstratified with beds of tripoli, composed of fresh-water diatoms, and layers of basalt. Some of the ash beds are almost entirely

composed of lapilli of soft cottony pumice, others are finer, grey, red, white, etc., and contain the trunks of coniferous trees, and in some instances are pierced with holes which represent the stems of upright plants, thickets of which were buried by the descending showers or rapidly accumulating sediment of volcanic ash. Here the source of the materials is to be sought in the line of great volcanic vents which crown the summit of the Cascade Mountains, and from which, at intervals, were emitted either floods of lava, poured down on to the plain along the eastern border of the range, or showers of ashes which, borne inland by the prevailing westerly winds, fell on forest, savannah and lake, temporarily destroying animal and vegetable life, and forming, when falling or washed into water basins, strata which alternate with fossil-beds, the accumulations of quieter times. In other places these tufaceous deposits were washed from all the highlands into the valleys, forming local masses of considerable thickness without the intercalated beds mentioned above.

The accompanying section, copied from my report on the Geology of Northern California and Oregon (Pacific R. R. Report, Vol VI, Geology, p. 47), will illustrate the deposition of these tufaceous rocks in the lake basins where they are interstratified with the fossiliferous beds.

Dec. 12, 1881.

Section of Geology.

The President, Dr. J. S. Newberry, in the Chair.

Forty one persons present.

Mr. N. L. Britton presented

"Additional Notes on the Geology of Staten Island."*

Two wells have recently been sunk to a considerable depth on Staten Island, in the vicinity of Stapleton. One of these is on the property of Mr. J. J. Cisco, near the summit of the Serpentine hills; the section as given by the Superintendent of the Pierce Well-boring Co., who sank it, is as follows:

Glacial drift	50 feet.
Soapstone	150 feet.

The well is six inches in diameter, and sufficient water was obtained to make it a success.

The other well is at the pump-house of Bischoff's Brewery, some 500 feet east of the most eastern serpentine outcrop at the foot of the

* These notes are supplementary to the paper on this subject read by Mr. Britton on April 4, 1881. (Ann. N. Y. Ac. Sci., II, 161.)

hills. This has now (Dec. 1st) reached a total depth of 210 feet, and the boring is still unfinished. The section thus far has been as follows:

Glacial drift..... 80 feet.
Various kinds of tough hornblende schist, apparently varying to serpentine.....130 feet.

As yet no gneiss nor granite has been reached.

An outcrop of clay occurs near Clifton, about three-fourths of a mile south of the Forts, near the southern edge of the terminal moraine; it has been found, by borings made by Mr. Charles Townsend, in excavations for cellars, to be at least ten feet in thickness, and of a light color.

The clay is probably of Cretaceous age, and if so, this is the most eastern point at which beds of that age are known on Staten Island.

Mr. W. T. Davis has recently observed a large fossiliferous boulder of Schoharie Grit on the shore at Brighton Point. The fossils have been submitted to Dr. Newberry, and the following species identified:—*Dalmanites anchiops*; *Orthoceras Pelops*, *Strophodonta hemispherica*, *Atrypa reticularis*; *Strophomena rhomboidalis*; a *Fenestella*; and *Zaphrentis prolifera*.

Glacial groovings have recently been noticed on the hornblende-rock which is exposed at tide-level on Brighton Point. Some of the grooves are at least one-quarter of an inch in depth, three inches wide and four feet long. Their bearing varies from N. 15° W. to N. 17° W.

Discussion.

Prof. D. S. Martin considered the specimen of so-called hornblende schist from the well-boring, not to consist properly of that rock, but to be partly hydrated—apparently a less altered condition of the rock which higher up gives us the soft, semi-fibrous serpentine of the island.

Dr. Newberry regarded the serpentine of Staten Island as probably a pseudomorphous condition of hornblende slate. It differs considerably from the mottled serpentine of New York Island, which is "verde antique"; that is, is composed partly of serpentine and partly of carbonate of lime, and is scarcely distinguishable from the Moriah marble, which is quarried at Moriah, Thurman, etc., in the Adirondack region. It is a peculiar rock, and one of the connecting links between the rocks of New York Island and those of northern New York and Canada. Taken together, these afford strong indications of the Laurentian age of the New York Island and Staten Island crystalline rocks.

Dr. Newberry further said that the accurate determination of the age of the rocks of New York Island, of Staten Island, and of those underlying the drift of Long Island, was in the highest degree desirable and important; and while he was satisfied that the former were Laurentian, and the latter Cretaceous, it was eminently desirable that unquestion-

able proof should be found of this, if it is true. At present no positive assertions could be made, and the duty devolves on the geological members of the Academy to rid the subject of doubt.

The fossils in the boulder referred to by Mr. Britton prove to have come from the Schoharie Grit. In its original condition this was a hard, compact blue limestone, but is here presented in a leached state, by the passage of waters containing carbonic acid, with a loss of its lime, color, and density. It was derived from northern New Jersey, to which locality a belt of this rock runs down from Schoharie county. Its transit by ice was effected without doubt through the valley of the Hackensack, which lies east of the Orange Mountains and west of the Palisades. This glacial movement is indicated by the direction of the striæ observed by Mr. Britton, as well as of those in the Hackensack valley.

Mr. A. A. JULIEN recalled the results of his lithological examination of the serpentines both of Staten Island and of Hoboken, presented before the Academy two years ago, in which it was shown that sections of all these rocks abounded in minute fragments of more or less altered amphibole. The conclusion then stated, that these serpentines must be certainly derived from hornblende schist, was confirmed by the interesting discovery of the latter rock, both in well-boring and on Brighton Point. Serpentines of the same general character and origin occur frequently throughout New York and Westchester counties. The mineral serpentine is also found in small quantity as a vein-deposit, not pseudomorphous, like the main mass, but presenting an amorphous material with banded vein-structure, associated with magnesite, dolomite, etc.; e. g., the marmolite of Staten Island, a translucent green variety found at Hoboken, and also at West 60th street on New York Island, etc. At all these localities the amphibole survives in a more or less altered condition; e. g., the tremolitic talc schists and slaty tremolitic serpentines of Staten Island and Hoboken, the hydrous anthophyllyte and unaltered tremolyte rock of West 60th street, New York, the tremolitic amphibolyte of New Rochelle and Rye, in Westchester county, etc.

Mr. BRITTON confirmed the last remarks, by the statement that a stratum of material, strongly resembling the hydrous anthophyllyte of New York, had been struck at the bottom of one of the wells on Staten Island; also that veins of mixed serpentine and calcite were observed at Stapleton, possessing a banded structure parallel to their walls. At that point the apparent thickness of the serpentine bed is 150 feet, but the crest of the hill is composed of talcose schist.

MR. W. LE CONTE STEVENS then read a paper on "THE MAMMOTH CAVE OF KENTUCKY."

He also exhibited specimens of the blind fish (*Amblyopsis spelaeus*), and blind crawfish (*Cambarus pellucidus*), and stereoscopic views of various points in the interior of the cave.

(Abstract.)

At the close of the Cincinnati meeting of the American Association for the Advancement of Science, in August last, he was one of a party of seventy-five members who visited the Mammoth Cave, remaining there two days, during which the greater part of the time was spent in exploration. He made no claim to new discoveries, but wished to call the attention of the Academy especially to recent observations, for the most part by Rev. H. C. Hovey, of New Haven, in regard to the temperature and structure of the cave. Mr. Hovey read a paper on this subject in Cincinnati, only a brief abstract of which has yet appeared in print, making use of a map, which is the first of its kind ever exhibited. The strictest precautions are observed by the authorities controlling the cave to prevent visitors from taking surveying instruments in with them: but the present manager, Mr. Francis Klett, has made a careful survey of the most interesting parts, and in time this will probably be given to the public, though possibly the scale of measurement may be withheld.

The central and right-hand portions of the map exhibited by Mr. Stevens had been enlarged by him from a copy of Mr. Klett's map. The left-hand portion was drawn only from recollection of the localities traversed, and not to scale, being intended only to illustrate principles. The same remark applies to the vertical projection, the lettering of which corresponds with that of the horizontal projection.

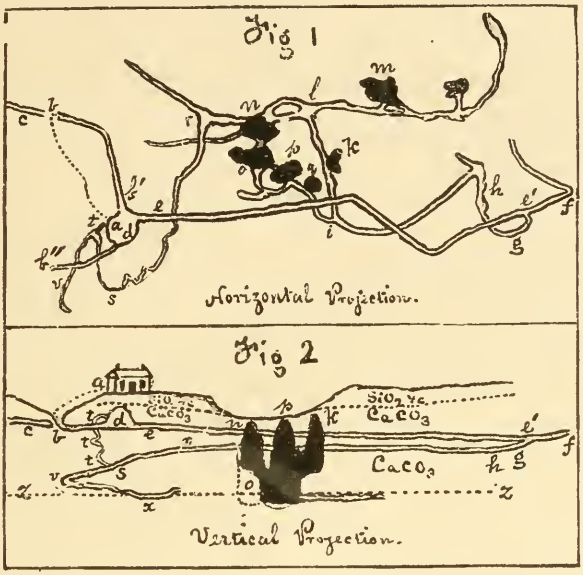
The temperature observations of Mr. Hovey were conducted with much care, and the very best instruments had been confided to him by the Director of the Winchester Observatory at New Haven. In August, 1881, while the external temperature at the neighboring hotel varied between 90° F. and 100° F., at points farther than 100 yards within the cave, the reading of the thermometer was never more than 56° nor less than 52½°, the mean temperature being 54° for the summer months. At a point 1,000 yards within, a thermometer had been left for six months, including the autumn and winter, and daily visited by Mr. Klett, who reported the variation to be only from 54° down to 53°. The underground temperature in this latitude, for points 60 or 70 feet below the surface, is usually assumed to be constant and about the same as the mean annual temperature above. According to Prof. Guyot's maps, the isotherm of 60° passes about thirty miles south of the Mammoth Cave, while that of 50° passes about forty miles north of Cincinnati. The temperature of the Mammoth Cave is

fully 6° lower than has been commonly supposed, and may be taken as a fair representation of that of the crust of the earth in the country immediately surrounding it.

Mr. Stevens exhibited a geological map of Kentucky, showing the area of sub-carboniferous limestone in which the Mammoth Cave is situated. This is overlaid with a thin stratum, mostly of sandstone, that is pierced by thousands of sink-holes, through which the surface drainage is carried down into limestone fissures and thus to the general drainage level of the Green River. This stream passes at the distance of less than a mile from the Cave Hotel, the floor of the latter being 312 feet above the water and 118 feet above the mouth of the cave. He briefly explained, with a diagram, the general mode of cave-production in limestone strata, showing that subterranean tunnels must be started by the solvent action of slightly acidulated rain-water, and subsequently enlarged by erosion, along the fissures in the limestone. These agencies are still at work in portions of the cave, and the whole of this limestone country is thus honey-combed with caverns. No tunnel can be thus formed at any point lower than the general drainage level, since there must be an exit for the saturated water. The production of the fissures is referable to the general upheaval of this area at the close of the coal period: but, that there has been subsidence since the completion of much of the Mammoth Cave, is indicated by the fact that at its lowest parts to-day the floor is covered with water to the depth of thirty feet or more, having subterranean connection with Green River. The fissures intersect at various angles, but many of them are nearly or quite coincident with the dip of the strata, which is very gentle. Water passing through these forms the tunnels, while that passing through the vertical fissures scores out the pits which pierce them. The same pit, starting from a sink-hole at the surface, may have successively lower tunnels as exit passages. If the visitor encounters it while walking through the higher, and therefore older, tunnel, the upper part appears to him as a dome, the lower as a pit.

The rate of erosion in the Mammoth Cave has been variable. The older parts are perfectly dry, and entirely free from stalagmitic deposits, indicating rapid erosion, followed by elevation, so as to deviate the water completely into other channels. In the newer parts the water is still dripping from the surface above, and depositing stalactites and stalagmites; but as a whole the cave is by no means remarkable for these formations, being much surpassed in this respect by the neighboring White's Cave, of more recent origin. Those which do occur are moreover deeply colored with iron, which exists in the soil in the form of both oxide and sulphide. In the dry parts, the ceiling of the cave is more or less covered with efflorescent calcic, magnesic and sodic sul-

phates, which contrast with the iron-stained limestone, giving rise to the beautiful effects that have conferred celebrity on the opening known as the Star Chamber, and the myriad rock flowers of Cleveland's Cabinet.



The structure of the pits and domes was then illustrated with the aid of the accompanying map, by describing a journey through the cave. From the hotel, (*a*, figures 1 and 2,) the visitor walks to its mouth (*b*), by the side of a shallow ravine, terminating in what was formerly a large sink-hole. The door of this fell through, about seventy years ago, producing the present mouth of the cave, and cutting off part of the gallery, now known as Dixon's cave (*c*), which opens out near the Green river, a half mile distant. A walk of 1000 yards brings him to the Great Rotunda (*d*), about 170 feet in diameter and 100 feet high. It is immediately under the hotel, its roof being not more than 40 or 50 feet from the surface. Besides the gallery, called the Narrows (*b'*), by which access has just been obtained, another tunnel from the further side terminates in the Rotunda, to which the name of Audubon's avenue (*b''*) has been given. The large, almost hemispherical opening, seems to have been cut out by the meeting of nearly opposite streams of water, which found exit, probably, through the main cave (*e*). At some distance within Audubon's avenue, a small opening in the floor is found, connecting it with the roof of the Mammoth Dome, a vast cavern

400 feet long, 100 feet wide and 250 feet high. These figures are of course only approximate, but it is believed that they are not exaggerated. Into this cavern the water is still trickling, and stalagmites are forming with sufficient rapidity to have cemented firmly to the floor a lamp dropped in 1812 and found in 1843. Returning to the Rotunda and passing through a half mile or more of the main cave, the visitor reaches, at *e'*, a large fallen slab of limestone to which has been assigned the title of "The Giant's Coffin." This makes the entrance to a side passage (*g*) which leads off to the lowest part of the present cave. The main cave forms an acute angle (*f*) and may be followed for several miles, terminating abruptly in a pile of rocks, where the roof has fallen in the same manner as at the terminus of Dixon's cave. Many of its side passages and avenues are yet unexplored.

Returning and entering the side passage near the Giant's Coffin, the visitor passes obliquely beneath the main cave, starting upon what is known distinctively as the Long Route. At an expansion (*h*) are successive deposits of gravel, sand and clay, indicating the downward course of the water which was here partially arrested. Some distance further on, the passage forks (*i*). Keeping to the right, the dangerous Side Saddle Pit (*k*) is encountered, which measures 65 feet in depth and 20 feet across. It is surmounted by Minerva's Dome, 35 feet high. The pit yawns across the right half of the floor of the tunnel, leaving a narrow path on the left. A short distance beyond (*l*), the tunnel again forks. Keeping to the right as before, Gorin's Dome (*m*) is reached, and may be viewed with the aid of magnesium lights, from a small opening on the side, ten feet above the pathway. The abysm extends 117 feet downward, 100 feet upward and 60 feet across. Leaving this and passing the fork (*l*), the tunnel is completely interrupted by the so-called Bottomless Pit (*n*) across which a bridge has been laid, resting upon a ledge. Despite its ominous name it does not defy measurement, having been found to be 95 feet deep on one side of the ledge and 105 feet on the other. Almost immediately overhead is Shelby's Dome, 60 feet high. Between the Bottomless Pit and the Side Saddle Pit are a pair of very large pits, discovered not a year ago by one of the guides, William Garvin, and examined for the first time last August by Mr. Hovey, who gave to them the names Scylla (*p*) and Charybdis (*o*) on account of the narrow, rugged passage which separates them and the great difficulty and danger of access. By timing the fall of pebbles into the water at the bottom, the depth of each was ascertained to be about 200 feet. Charybdis was seen to be directly connected with the Bottomless Pit. Indeed the latter may be regarded as only a part of Charybdis, its depth, 105 feet, being that of a jutting ledge, or the floor upon which water ceased to fall after being slightly deviated into

Charybdis, where the sound of its trickling is still audible. Shelby's Dome is simply the upward continuation of this combined pit. So narrow, moreover, are the ridges separating Scylla from Charybdis on the one side and from the Covered Pit, (*q*), on the other, and so small is the distance to the Side Saddle Pit (*k*), that it seems in the highest degree probable that this group of pits compose merely the upper branches of a single large pit into which they are all united, or at least directly connected before the bottom is reached, and the small relative depth of the Side Saddle Pit is explicable in the same manner as that of the Bottomless Pit. Such an extraordinary group of pits, forming an apparent nucleus of cave drainage, might be expected to have its counterpart in an unusually large depression, or group of sink-holes, at the surface. Impressed with this idea, Mr. Hovey found in the woods, scarcely half a mile from the Hotel, in the known direction of these pits, a depression (*p* Fig. 2.), many acres in extent, and so deep that from its edge he could overlook the tops of the pine trees that rose from the middle.

Leaving this region of pits and domes, the route leads still downward, passing again under the main cave through the narrow tortuous channel known as "Fat Man's Misery" (*s*) where the distance from floor to roof is in many places not more than three feet. Through the floor a winding passage has been worn away, varying in width and depth from one to three feet. This terminates in a chamber which has received the appropriate name of "Great Relief," where the succession of pebbles, gravel, sand and fine clay again records the work of erosion and deposit. This bed is not more than 50 or 60 feet above the drainage level, and from here down to the River Styx, the ground becomes more or less damp. A succession of bodies of water are then encountered, including the tubular Echo River, which is navigated in boats. It is a part of the tunnel which has subsided below the water level, and is in connection with Green River, being filled to within a few feet of the roof in summer, and completely closed in winter when the Green River rises. The column of air between the water and the impervious roof, closed everywhere except at the two ends, which are three-fourths of a mile apart, serves as a resonator for any note within the range of the human voice, and multiple echoes gliding imperceptibly into each other, continue to be returned for many seconds after the voice has been hushed.

Beyond Echo River, the cave may be followed with continual ascent, through Silliman's Avenue, the Pass of El Ghor and Cleveland's Cabinet, for about five and a half miles. A pile of jagged rocks, 100 feet high, is then surmounted and the wearied climber is confronted with a large cavern, 100 feet wide and 70 feet deep, where three short branches have united in one tunnel. Following the left branch for a

few yards, a hall is found, in the floor of which is a pit 175 feet deep. The corresponding dome overhead is scarcely noticeable as such, for the surface of the ground is not more than 30 or 40 feet distant. The end of the Long Route has been reached.

In returning, the passage through Fat Man's Misery is avoided, and nearly two miles of walking are saved by climbing through a very steep, narrow, winding "Corkscrew" pass (*l*, Fig. 2), starting from the neighborhood of Great Relief and terminating at the side of the Great Rotunda. The vertical ascent is about 140 feet. To even stout-hearted mountaineers, if stout-bodied also, this Corkscrew is an intensified Fat Man's Misery, and upon them it rarely fails to leave strong and deep impressions, which may be of more kinds than one.

In regard to the animal life of the Mammoth Cave, conflicting opinions have been expressed by those who have made a special study of this subject. The bats, lizards and rats that have been found cannot be strictly called cave-dwellers, as they are always at points not so far removed from the outer light as to make this inaccessible. The cave crickets and blind crawfish have particularly long antennae and acute powers of hearing. Most of the crawfish are pale in color, some of them almost white; and this feature has been attributed to the continued absence of light. Crawfish, however, with well developed eyes and of dark color have been often found. These are without doubt either wanderers from Green River or the immediate descendants of such; and many generations of cave-dwelling are required to bring about such changes as have caused the application of a specific name, *Cambarus pellucidus*, to the white variety with only rudimentary eyes.

In regard to the blind fish it is a significant fact that the rudimentary eyes of the young are apparently less atrophied than those of the mature fish. Although to these cave-dwellers also a specific name, *Amblyopsis spelaeus*, has been given, they are by no means the only fish found amid this stygian darkness. The existence of fish with perfect eyes, apparently prospering where eyes are useless, shows how much less dependent these creatures are than more highly organized vertebrates upon approximate uniformity in external conditions. To those who have already accepted evolution, there is far less difficulty in believing that the colorless blind fish are the modified descendants of dark-colored ancestors with perfect eyes, which have wandered from Green River into Echo River, than in concluding that they have always constituted a separate species, as held by Prof. L. Agassiz, and subsequently contended by Prof. F. W. Putnam.* Nevertheless, Prof

*The Mammoth Cave and its Inhabitants. By A. S. Packard. Jr., and F. W. Putnam, Salem, Mass., 1879.

Putnam has shown that the differences between the blind fish (*A. spelaeus*) and their nearest living congeners are much more than in respect to mere color of skin and power of vision. Whether the internal anatomical differences on which he reasonably lays much stress can be proven to be a natural result of the external conditions imposed by cave life, is a question which, if settled at all, must be settled by zoologists alone. Prof. A. S. Packard, jr., and Prof. E. D. Cope are as pronounced in their opinion that the blind fish have been evolved from fresh-water ancestors possessing good vision, as is Prof. Putnam in the opinion that their ancestry were denizens of salt or brackish water, with which he believes that the cave was supplied at a time when this region was a salt or brackish water estuary. Prof. Putnam therefore concludes that the blindness of these fish is in no respect a consequence of subterranean life.

DISCUSSION.

Mr. BRITTON inquired whether any flora existed in the cave.

Mr. STEVENS replied that, so far as he was aware, no kind of vegetation had ever been found within it.

Dr. NEWBERRY remarked on the geology of the region adjacent to the Mammoth Cave. The limestone beds of this high table-land are jointed in the manner common to rocks, apparently by some sort of polarisation, producing fissures which run in a north and south, and an east and west, direction. The plateau is about 500 feet above the drainage, part of the drainage passing into the Green River, and part into the Ohio. No streams occur on the surface and the drainage is quite gradual. At the angle between these two rivers several streams are seen, bursting out of the cliffs at various heights above the Ohio; they are, so to speak, subterranean sewers, representing the underground drainage of the country; at one point three such streams pouring out of the rock form very beautiful cascades; and near Sandusky a full grown river flows out of the cliff of cavernous limestone. The beds consist of lower carboniferous limestone, with sandy layers beneath. In the vicinity occur portions of the great "blue grass region," one of the oldest parts of the continent, once an extensive highland, forming an island in the sea. Around this, rims of sediments were deposited, consisting of sandstones and limestones; while on the other hand, the continuous process of erosion, during the lapse of a vast period, removed the material of the table-land within, and converted it into a broad depression or basin, the "blue grass region," above which the present plateau of the encircling sediments now rises to a height of 500 feet.

The erosion of the joints in this plateau has resulted in the formation of the pits described by Mr. Stevens, but it is probable that some

of these may reach 200 or 300 feet below the Ohio and Green Rivers. There is evidence, from borings in the Delta of the Mississippi, etc., that the continent was formerly more elevated, standing 500 to 600 feet higher at New Orleans than at present; the drainage was much freer, the Mississippi being a free flowing stream, as well as the Ohio and other tributaries. Borings have been sunk in the present trough of the Ohio river, to a depth of over 100 feet below its present bottom, without reaching the true bottom of the trough, the ancient bed of the river, which is perhaps from 100 to 200 feet further down.

Evidences of the same elevation of the continent were observed in caves on an island in Lake Erie. Long stalactites projected from the roof of a gallery whose end was ordinarily filled with water at the present level of the lake. At times a strong and steady wind has blown down the level of the lake and partially drained this gallery; but even then a guide, John Brown, resident on the island, has swum through the gallery and found the stalactites projecting from the roof as far as he could go.

In regard to the origin of the blind animals, the view of Prof. Cope is probably correct, that they have been derived from the degeneracy of ancestors that once had perfect eyes. No fish is formed with poor eyes; but any organ may be atrophied by disuse, with consequent feeble flow of blood, decreased nutrition, and inevitable shrinking of important parts. An analogy is shown in a comparison of the jaws of prehistoric and modern men. At present our "wisdom teeth" are useless, there is no room for them in the shortened under-jaw; our food being softened by cooking, cut up, and boneless, requires less vigorous mastication; and from disuse, and the consequently insufficient development, these teeth often speedily fall away. In the prehistoric man, on the contrary, the jaws were longer, roomier, supplied with more teeth—the "wisdom teeth" being well developed and kept in strength by constant use on coarse and rough food. The absence of the well-known stimulation produced by light, from the dark waters within the Mammoth Cave, has in the same way resulted in the atrophy of the organs of sight.

MR. STEVENS remarked in confirmation of this view, on the observation, first announced by Dr. Tellkampf, that the old fish found in the Cave have only rudimentary eyes, while in the young the eyes are simply imperfect, *i. e.*, the conditions tend to produce a reversion.

DR. I. P. TRIMBLE referred to his visits to the Mammoth Cave and its vicinity, the absence of fatigue in traveling within the Cave, and the occurrence of bats clinging to the walls at a point three-quarters of a mile from the entrance. He inquired concerning the condition of the eyes in the bats and crickets within the Cave.

MR. STEVENS replied that both species had eyes, externally and

apparently perfect. However, the antennæ of the crickets were remarkably long, and seemed to guide them more than their eyes. He related observations made by Prof. Putnam on the crickets, and also on the crawfish from the Cave, shut up in an aquarium, which seem to indicate that they judge of their food more by touch than by sight.

DR. NEWBERRY had observed in an old Spanish mine in New Mexico, millions of bats clinging to the rock, many of them with their young, at a point several hundred yards from the entrance. In all cases such denizens of caves find ready access to the exterior atmosphere through the crevices and galleries.

MR. STEVENS had observed bats at the same distance from the entrance as noted by Dr. Trimble. In regard to the absence of fatigue in traveling underground, he had found a walk of thirty miles had caused no more exhaustion than one of ten miles on the surface; this was probably due to the purity, coolness and dryness of the atmosphere.

Mr. BRITTON stated that a *Natural Science Association* had recently been formed on Staten Island, having for its particular object the collection and diffusion of information on all subjects relating to the Natural History of the Island, and the formation of a cabinet illustrative of its natural products. The meetings are held at New Brighton on the second Saturday of each month. The officers of the Association are:

President.....Sanderson Smith.
Corresponding Secretary,.... . .. .Arthur Hollick.
Recording Secretary,..... Charles W. Leng.
Curator.....William T. Davis.

The address of the Corresponding Secretary is at Port Richmond.

December 19, 1881.

SECTION OF PHYSICS.

Vice-president, Dr. B. N. MARTIN, in the Chair.

Thirty persons present.

A specimen of acicular hornblende in quartz was exhibited by MR. W. L. CHAMBERLAIN.

The following paper was read by Prof. W. P. TROWBRIDGE:

ON THE DETERMINATION OF THE HEATING SURFACE REQUIRED IN STEAM PIPES EMPLOYED TO PRODUCE ANY REQUIRED DISCHARGE OF AIR THROUGH VENTILATING CHIMNEYS.

To ventilate a room properly requires the frequent removal of vitiated air and the introduction of fresh or pure air, the quantity, by weight, of the air introduced and rejected being equal in a given time.

If the process be continuous, and the proper amount of air be admitted and removed every hour or minute, the only other requirements are that the entering air shall be pure, that it shall be properly warmed in cold weather, either before it enters the room or by the mixture and diffusion of warm and cold air in the room; and that the introduction and removal of air shall take place by gentle or inappreciable currents in such a manner that the pure air may be thoroughly diffused throughout the room before it is removed.

These simple rules are easily stated and comprehended. It is also well understood that to produce a movement of air requires force in proportion to the mass moved and the velocity imparted to it.

The problems which arise in ventilation consist mainly in determining the position, arrangement and sizes of the passages through which the air enters and leaves, and the proper adaptation of these passages to the forces which produce the movement.

On the correct solution of these problems, too often misapplied or misunderstood, successful ventilation depends.

The various modes of producing the movement of air for ventilation are:

First.—Ventilating chimneys or flues in which the movement is caused by the difference in weight between the heated air in the flue and the cooler air outside. This requires that the air before entering the flue shall be warmed, and the heat necessary may be that due to the heat of the room when fires are necessary for warmth; or the heat may be imparted by stoves in the base of the flues, by gas jets, or by steam-heated pipes.

Second.—The movement may be produced by fans or blowers or by steam jets - the latter being seldom applied.

The object of this paper is to investigate the laws which govern the ventilation when the air is heated at the base of the flues by steam pipes, the air in its passage to the flue receiving heat by its contact with the exterior surface of the pipes. As far as I am informed these laws have not heretofore been developed, and, as this system is a very simple one, capable of very extended applications, it is hoped that the following analysis may at least lead to a full discussion of the subject:

Let it be supposed that the air in a room is to be renewed at the rate of (W) lbs per second. Suppose also that it is to be rejected through a flue whose cross-section in square feet is (A), and height in feet (H). And that it is to be heated by steam coils whose aggregate exterior surface in square feet is (S)

The following notations will be used:

W. Weight of air removed per second (lbs).

H. Height of flue in feet.

S. Exterior surface of steam pipes (sq. feet).

A. Area of cross-section of flue (or flues).

T_a. Absolute temperature of external air (found by adding to the thermometric temp. Fahr. the number 459.4).

T_c. Absolute temperature of air in the flue.

T_s. Absolute temperature of steam in the pipes.

D_a. Weight in lbs. of a cubic foot of the external air.

D_c. Weight in lbs. of a cubic foot of the flue air.

V^1. The theoretical velocity of the air in the flue.

V. The actual velocity.

r. The rate in units of heat per hour, per square foot of the surface (S) (and for each degree difference between T_s and T_a) at which the air receives heat from the pipes.

k A coefficient of loss of velocity such that $kV=V'$.

p The unbalanced pressure (upward) due to the difference of weight between the column of air in the flue and a corresponding column of external air.

Then,

$$p=H.D_a-H\,D_c \text{ or } p=H\,(D_a-D_c) \qquad (1)$$

This pressure may be represented by the weight of a column of flue air of a height—

$$\frac{p}{D_c} = \frac{H\,(D_a - D_c)}{D_c} \quad , \quad . \qquad (2)$$

and the velocity in the flue will be found from the expression

$$\frac{V'^2}{2g} = \frac{H\,(D_a - D_c)}{D_c} \quad . \quad . \qquad (3)$$

or,

$$V' = \sqrt{2g\,\frac{H\,(D_c - D_a}{D_c}} \qquad (4$$

But from the Mariotte-Gay-Lussac law we have—

$$\frac{D_c}{D_a} = \frac{T_a}{T_c} \text{ or } D_c = D_a\,\frac{T_a}{T_c} \qquad (6)$$

substituting this value of D_c in formula (4) there results—

$$V' = \sqrt{2g\,H.\left(\frac{T_c - T_a)}{T_a}\right.} \qquad (7)$$

In this expression the theoretical velocity of flow is expressed in terms of the height of the flue and the absolute temperatures of the flue air and the external air. From formula (7) we have—

$$T_c - T_a = \frac{V'^2}{2g\,H} \times T_a \quad . \qquad (8)$$

The quantity of heat transferred to the air may be represented by

$$\phi = W.\,c.\,(T_c - T_a) \quad . \qquad (9)$$

in which ϕ represents the quantity of heat in units of heat per second, and c the specific heat of air at constant pressure ($c = 0.238$.)

All of the above formulas are well known. The following are believed to be new:

The quantity of heat imparted to the air may also be represented by $\phi' = \frac{S.\ r.\ (T_s - T_a)}{3600}$ in which is the quantity of heat imparted per second, and as from the nature of the problem $\varphi = \phi'$ we have

$$\frac{S.\ r.\ (T_s - T_a)}{3600} = W.\ c.\ (T_c - T_a) \quad (10)$$

or

$$T_c - T_a = \frac{S.\ r.\ (T_s - T_a)}{W.\ c.\ 3600} \quad . \quad . \quad (11)$$

combining this equation with (8) we have—

$$S'.\ r.\ \frac{(T_s - V_a)}{3600} = \frac{V'2}{2g\ H.} \times T_a \quad . \quad (12)$$

and

$$S' = \frac{V'^2.\ W.\ c.\ T_a}{2g\ H.\ r.\ \frac{(T_s - T_a)}{3600}} \quad . \quad . \quad . \quad (13)$$

This expression gives the total heating surface in the pipes in terms of the velocity, the height of the flue, the weight of air discharged per second, and the absolute temperature of the external air.

If we substitute for V′ its value in terms of V, the actual velocity, we have—

$$S' = \frac{K^2\ V^2\ W.\ c.\ T_a}{2g\ H.\ r.\ \frac{(T_s - T_a)}{3600}} \quad . \quad . \quad (14)$$

and others

$$W. = D_c\ V.\ A.$$

$$S' = \frac{K^2\ V^3\ D_c\ c.\ A.\ T_a}{2g\ H.\ r.\ \frac{(T_s - T_a)}{3600}} \quad . \quad . \quad (15)$$

another expression for S'.

These two expressions exhibit the laws of the movement of the air, giving the quantity of heating surface required under any special conditions of area and height of flue, temperature of external air, and velocity of discharge.

The constant (r) may be found approximately from the experiments of Mr. C. B. Richards, made at Colts Arms Co., of Hartford. The constant K depends upon the frictional resistance which the air encounters in its passage into and through the flues. The velocity V may be assumed, and should not be greater than four or five feet per second. The smaller the velocity and the larger the flues, the less will be the required heating surface, and the greater the economy of the apparatus for ventilation.

The following paper was read by Prof. H. L. FAIRCHILD:

ON A PECULIAR COAL-LIKE TRANSFORMATION OF PEAT, RECENTLY DISCOVERED AT SCRANTON, PENN.

The material which we shall notice this evening has naturally been regarded, on account of its associations, as illustrating in some degree the formation of coal. A brief description of that alteration of peat which has resulted in the formation of coal, is therefore desirable.

Peat results from decomposition of vegetable matter under water. The latter excludes the atmosphere and largely prevents the oxidation, which removes the vegetable debris on the upland, and which if rapid we call combustion, or if slow, decay. In northern regions peat-swamp vegetation is commonly a sort of moss (Sphagnum) which grows upward as it dies below. Great peat deposits are also produced in lower latitudes from the debris of forest trees. The great Dismal Swamp is a fine example, and in the Hackensack and Newark meadows we have examples of peat-formations of great depth, produced by the slow subsidence of the region and the accumulation of salt-marsh vegetation.

In former geological ages, immense peat deposits were produced in the vast lowlands along the borders of the continents, or at the deltas of the ancient rivers. These great swamps were frequently submerged in the sea and deeply buried beneath mud and sand. This event occurred perhaps many times in a single locality. The buried peat slowly decomposed. Much of the hydrogen and oxygen of the vegetable tissue, and some of the carbon, were eliminated. The remainder was consolidated by the weight of the superincumbent strata, and the result is bituminous coal. Thus we have the six to twenty coal beds of Pennsylvania, or the one hundred coal-seams of Nova Scotia.

The evidence that our coals are primarily formed in this manner is abundant, clear and incontrovertible. Few subjects are by our inductive science more definitely settled than this. We find these buried vegetable deposits in every stage of decomposition and alteration. Where the containing rocks are undisturbed, lying in their original positions, the coal contains a large proportion of volatile matter, and is bituminous. But where the rocks are dislocated and folded the coal is, by the pressure and heat, changed to anthracite or perhaps to graphite. The proportion of fixed carbon, or the degree of alteration, is always proportionate to the amount of disturbance which the associated rocks have suffered. Hence anthracite coal is a metamorphosed coal, just as marble is metamorphosed limestone, or quartzyte is metamorphosed sandstone. The metamorphism of coal is still going on. The escape of the volatile matter, in which the change consists, is

observed in the mines, in the production of the explosive "fire-damp," and the poisonous "choke-damp."

Running from cellulose through wood, peat, and coals up to graphite we have a complete series; the difference being the loss of hydrogen, oxygen and in a less degree of carbon. This table, after LeConte, exhibits the proportions of the elements *by weight*, the carbon being reduced to a fixed quantity:

	Carbon.	Hydrogen.	Oxygen.
Cellulose	100	16.66	133.33
Wood	100	12.18	83.07
Peat	100	9 83	55.67
Lignite	100	8.37	42.42
Bituminous Coal	100	6 12	21.23
Anthracite Coal	100	2.84	1.74
Graphite	100	0.00	0.00

Anthracite coal, it will be seen contains a very small proportion of volatile matter, and graphite none at all. No two specimens of coal from different beds or areas are likely to yield upon analysis exactly the same results. This is due to differences in degree and manner of decomposition, the varying degree of metamorphism, the varying impurities, and perhaps a difference in the kind of vegetation. Anthracite coal naturally contains more ash than bituminous, because it is more concentrated, and of course peat has the least proportion of ash, simply derived from the inorganic matter of the plant.

The substance to be described was found in a peat-bog in the city of Scranton during the past summer. It has received attention from the newspaper and scientific people of the eastern coal region of Pennsylvania; and has been recently mentioned in the *Am. Jour. of Science* for Dec. by a quotation from a letter of a Scranton gentleman to the *Engineering and Mining Journal.*

Scranton lies in the midst of the Lackawanna anthracite coal-basin, which forms the northern half of the Wyoming basin. Since the financial panic of 1872 the city has grown but slowly, and a swamp lying in the midst of the city had remained unoccupied, except as an old dumping-ground for cinders from the furnaces. The city having been lately made the county-seat of the newly created Lackawanna county, this swamp was selected as the site for a court-house. In excavating for the foundations there was found a bed of excellent peat, 10 to 14 feet deep. I visited the excavation and collected specimens from depths of 3, 5, 8, and 13 feet. These specimens, of which a series are before you, were, of course, when fresh and saturated with water several times their present bulk.

The peat from the greatest depth was highly decomposed, or very "ripe." It was fine-grained, close in texture, and although soft held

its shape well, cutting like cheese. The color, when freshly cut, was a yellowish-brown, but changed rapidly to a dark-brown, almost black, in a few minutes. Upon drying, the color becomes a lighter or grayish-brown. The rock below the ripe peat is a clayey sand. This is somewhat impervious to water ; but it is likely that beneath it is a more clayey bed which originally held the water and occasioned the swamp.

In the midst of the ripe peat, termed muck in the letter above mentioned, there was found, at various times and at different places, in excavating for the division walls, a substance resembling to the eye a bright coal—anthracite if you please. This did not occur in beds or layers, or in any apparent regular manner, but in irregular scattered or branching masses. You will observe in these dried specimens how intimately the coal-like matter and the ordinary peat are mingled. The two kinds cannot be separated, and it is with difficulty that the dried material can be gotten entirely pure for purposes of analysis. It shrinks upon drying, to a greater degree than the unchanged peat. Masses which I thought would afford fair-sized dry samples have nearly disappeared. The fresh material has been described as a tough jelly, which is perhaps a fair description. It was somewhat elastic, like a mass of soft india-rubber, but would break before bending greatly. I should compare it to a very firm but brittle jelly. The fracture had the lustre of a true coal, and in the dried state the resemblance is perfect. Being found in the midst of an anthracite basin, unscientific people naturally supposed from its associations that whatever bearings it might have upon coal would relate to anthracite coal, not knowing, or not remembering, that anthracite is a metamorphic coal.

Mr. N. L. BRITTON, Geological assistant at the School of Mines, New York, has made approximate analyses of this altered peat, from material which I carefuly selected ; also of the peat contiguous to the transformed matter (within the distance of an inch) ; and of the ripe peat from a depth of 13 feet in another part of the excavation. The analyses are of thoroughly and equally dried samples, and afford the following percentages :

	Moisture at 115° Cent.	Volatile Matter.	Fixed Carbon.	Ash.
1. Ripe Peat	6.225	63.875	4.625	25.275
2. Peat adjacent to 3	3.775	22.125	4.625	69.475
3. Transformed Peat	11.350	52.800	24.725	11.125
4. Transformed Peat	66.758	9.826	4.012	19.404

Number 4 is by the Pennsylvania State Chemist, as published in the

American Journal of Science. The moisture is taken at 212° Fahr., and the analysis is evidently of the fresh material.

To obtain a fairer comparison, and if not strictly accurate, yet sufficiently so for our purpose, I have computed the percentages with the moisture eliminated.

	Volatile Matter.	Fixed Carbon.	Ash.
1. Ripe Peat	68.115	4.932	26.953 (White)
2. Adjacent to 3	22.993	4.806	72.201 (White)
3. Transformed Peat	59.560	27.891	12.549 (Pink)
4. " (State Chemist)	29.559	12.069	58.372
Bituminous Coals	30. to 60.	40. to 70.	3 to 6

From this table it will be seen that the composition of the transformed peat, number three, is about that of a very "fat" bituminous coal, that is, one containing a large proportion of volatile combustible matter, such as are desired for making gas. In number four, the volatile matter and the fixed carbon have nearly the same proportion to each other.

The very large amount of ash in these samples is to be expected, on account of the small size of the peat-swamp, which allowed much inorganic matter to be blown or washed in over the whole surface. But the varying amount of ash would indicate that the peculiar physical character of the peat was not due to the *amount* of inorganic matter. The ash of numbers one and two was white, while that of number three was decidedly pink. This color probably indicates iron; which may possibly afford a clue to the cause of the transformation. The presence of considerable iron either inherent in the mass itself, or derived from the surrounding mass by something like concretionary action, would probably hasten the decomposition; bearing upon this point, the large amount of inorganic matter without iron in the peat contiguous to the transformed peat is remarkable. The physical characteristics are undoubtedly due to the finely divided state of the carbon, mingled with the water and volatile matter. But, however produced, we have here something that is apparently coal, in the midst of peat that is not yet coal.

Except as this substance illustrates a degree or phase of peat decomposition, it is not likely to have any bearing on the formation of coal. The decomposition of a buried peat-bed under great pressure probably involves the whole mass at the same time, and does not proceed by the expansion of such centres of decomposition as are here found.

Samples have been placed in the hands of Mr. Spencer B. Newberry, of Cornell University, who is making a full chemical examination.

DISCUSSION.

DR. L. ELSBERG then said that some 20 years ago he was engaged in experiments on the subject of converting peat into coal by a more rapid process than that occuring in nature. He found that moisture, heat and pressure were, as he supposed, the elements which, together with time, na ture had employed; and these three factors could and can be used really to make a very good coal. On some future occasion he would bring specimens of the manufactured coal and of various kinds of coal to the Academy, and give an account of these experiments and the methods. For a long time his experiments were futile, because it was impossible to make a machine of iron or steel strong enough to withstand the pressure which must be applied to the prepared pulp to reduce it to coal. By the action of super-heated steam, peat is converted into a perfectly homogeneous pulp. By passage of this through any of the ordinary compressing machines used for making bricks, etc., blocks or cylinders are obtained of a substance which, so far as its economic uses are concerned, is not inferior to most qualities of bituminous coal, for gas or fuel. Every effort was made to render the bore perfectly smooth and polished in the cylinder from which the peat was finally pressed out, and for this purpose even glass and porcelain were employed. However, the peat was found to be so impalpable that it was forced into the microscopic pores of the metal, and even of porcelain and glass. The peat thus inserted itself in the finest possible particles, which acted like wedges, chipping off small pieces from the interior of the cylinder. No matter how fine and smooth the bore of the cylinder was made, after very beautiful working for a few days, gradually this material would insert itself in the microscopical interstices of the metal, until gradually the working of the machine was stopped or an explosion ensued. A great many trials were made and much money spent, and finally the enterprise was given up.

MR. A. A. JULIEN remarked upon the voluminous literature connected with the study of peat, and the widely varying results, notwithstanding the enormous amount of labor that has been expended. The study of this material has been approached by investigators from two economic points of view; its relations to agriculture, and its employment as fuel. In investigations of the former class the larger number of analyses have been ultimate—*i. e.*, to determine the carbon, oxygen, hydrogen, nitrogen, etc., which make up peat and its allied products. This gives very conflicting results; the slightest possible change in the amount of water, the oxidation or dissociation of the material, even while during analysis, yielding very different results even in the hands of a single investigator. The other method is approximate, simply intended for the estimate of the value of coal or peat as applied to the

purposes of fuel, and is that represented in the analysis of Mr. Britton. Such analysis, however, can throw but little light on the origin of the substance; organic acid seems to be further indicated by the red ash derived from the coal-like substance (Analysis No. 3), the white ash of the enclosing peat showing the residue of silica and alumina insoluble in the humous acids.

Further, the physical characteristics of the substance described by Prof. Fairchild, its brittle jelly-like character while moist, and extreme shrinkage on drying to bright coal-like brittle flakes, are identical with those of apocrenic, humic and other organic acids. These considerations render it highly probable that this substance has been produced within the peat at Scranton merely by the leaching out of the upper portions of the bog and the concentration of soluble salts of organic acids, in part crenates, along certain planes and in small cavities within the denser part of the peat toward the bottom of the bog. There is as yet no evidence, however, that these facts have any important connection with the formation of bituminous coal, much less with that of anthracite, represented by these specimens. A third method of the examination of peat is founded upon the determination of its proximate constituents or compounds, both those of amorphous character and various organic acids. From insufficient knowledge of the exact constitution and nature of these acids, especially in their various hydrated forms, the method is very difficult and has thus far had but limited application. Only such a mode of examination can throw light upon the character of the bright jelly-like substance in the Scranton peat.

Some statements by Prof. Fairchild, however, give a clue to its identity. He has mentioned a rapid change of color in specimens of the peat taken from a depth of thirteen feet, the yellowish-brown color of the surface becoming blackish brown in a few moments while being handled. This seems to indicate not the trifling change produced by drying, but the characteristic reaction of crenic acid, well known to chemists by its immediate oxidation and partial conversion into apocrenic acid. This affects not only the acid but its ordinary salts, *e. g.*, those of iron, and has been observed both in its artificial product in the laboratory, and in nature, in the deposit of iron crenate beneath peat bogs and from the waters of many springs.

Prof. D. S. MARTIN called attention to the resemblance of the lighter colored and solid variety of this peat to the darker variety of the "turba" of Brazil. In the latter he had also observed thin seams of a black bituminous substance looking much like that which occurs in this peat.

The subject was further discussed by Prof. Hubbard and Mr. Parsons.

January 9, 1882.

REGULAR BUSINESS MEETING.

The President, DR. J. S. NEWBERRY, in the Chair.

Number of persons present, 43.

On the recommendation of the Council, the following-named persons, previously nominated, were elected as resident members.

C. H. DENISON,	CHARLES KIRCHHOFF, E. M.
SAMUEL HENSHAW,	EDWARD W. MARTIN,
E. F. HYDE,	W. H. RUDKIN,
VINCENT C. KING,	WALTER LE CONTE STEVENS,

DR. PHILIP VALENTINI.

PROF. J. J. STEVENSON called attention to the announcement of the death of one of the oldest and most eminent fellows of the Academy, Prof. John W. Draper, and after making some remarks thereon, proposed that the society proceed to take some suitable action.

THE PRESIDENT spoke of the eminent fame of Dr. Draper, and suggested that a committee be appointed to prepare a minute expressive of the feelings of the Academy. On motion, it was voted that such a committee be designated by the chair; and Prof. Stevenson and Prof. D. S. Martin were so appointed.

Among the books received, the President called attention to the first number of the "*Bulletin of the American Museum of Natural History*," as marking an important step in the progress of science in New York city. He welcomed the appearance of this publication, which contains novel and valuable matter, with illustrations accompanying descriptions of new species; and earnestly hoped that a large and liberal and worthy policy would enable the Museum to give to the world, in this manner, the benefit of the large stores of scientific material which it has already accumulated, and which will gather more and more around such a centre.

DR. LAURENCE JOHNSON then read a paper of which the following is an abstract.

THE PARALLEL DRIFT-HILLS OF WESTERN NEW YORK.*

(Abstract.)

That section of New York State lying between Lake Ontario on the north, and Cayuga and Seneca lakes on the south, is occupied by a large number of parallel drift-hills, having a general north and south direction. Some of them are two or three miles long, and attain elevations

*This article will probably appear in full in the ANNALS of the Academy.

of 100 or 200 feet above the intervening valleys; but the greater number are shorter and lower. Many of them were, when first cleared of timber, very steep at their north ends, and on their east and west sides; but, with very rare exceptions, the southern slope is gradual.

The large valleys are generally cup-shaped, the lip of the cup being of drift material, as found by many sections observed and cited by the writer. Such valleys were originally occupied by ponds or lakelets, now obliterated by accumulations of muck or peat, though a few (Crusoe lake, Duck lake, etc.,) still remain,

The surface rocks of the region, are, beginning with the lowest, the Medina Sandstone, Clinton Group, Niagara Group, and Salina Group. The Medina occupies the surface for two or three miles south of Ontario, lying at about the level of the lake in the vicinity of Great Sodus and Port Bays; while at Oswego Falls, twenty-four miles east, and at the lower falls of the Genesee, fifty miles west, it rises 100 feet above this level—indicating a shallow valley existing, previous to the ice period, in the region occupied by the parallel hills. The Clinton and Niagara Groups together occupy a tract of four or six or more miles wide throughout the district, the latter forming the watershed between the small streams flowing north directly, or south by a circuitous route to Lake Ontario. From the Niagara Group to Cayuga and Seneca lakes, the surface rock is the Salina, which here attains its greatest breadth in the State. Above and to the south of the Salina, rise in succession the Waterlime, Oriskany, Upper Helderberg and Hamilton, in the latter of which are excavated the basins of Canandaigua, Seneca, Cayuga, Owasco, and Skaneateles lakes. The escarpment of the Upper Helderberg limestones bends several miles to the south when approaching Cayuga and Seneca lakes. This fact, taken in connection with the great depth of these lakes—more than 400 and 600 feet respectively—indicate that in this region was exerted the maximum of glacial force in western New York.

To return to the hills. These are covered to a greater or less extent with bowlders of all sizes, up to three or four feet in diameter, composed of Medina, crystalline, Hudson River, Niagara and Clinton rocks —their relative proportions being in about the order named. Their abundance diminishes from the Niagara outcrop southward. The surface soil, a sandy loam, shades downward into a non-bedded, tough clay, generally red, filled with small, sub-angular, glaciated pebbles and bowlders—in short, a typical bowlder clay, or till.

The opinion held by the state geologists, forty years ago, that these hills were formed by streams of water, is evidently erroneous, since there are no accumulations of river gravel in the valleys, such as must have remained had a broad sheet of drift suffered aqueous erosion. More-

over, the valleys are cup-shaped, even the large river valley exhibiting this feature at a number of points cited by the writer.

Nothing but glacial action is competent to explain the peculiar shape and positions of these hills and valleys ; and the glacier which deposited them must have moved in a general north and south direction, bearing, however, eastwardly to the east of Cayuga Lake, and westwardly west of Seneca Lake. The long axes of all the smaller lakes in this region prolonged, converge toward a point on the present Canadian shore of Ontario. This fact would seem to indicate conclusively that the glacier radiated in cutting through, or passing over, the mountain ridge, exerting, as has been said above, its maximum of force about Cayuga and Seneca lakes. The amount of erosion indicates that the glacier occupied this region for an immensely long period; and the writer thinks he is supported by the evidence in believing it one of the first to come and last to go of all the ice-streams which swept over New York State. The evidence is, moreover, conclusive that the direction of the glacial current in this locality was not south-westerly, as generally maintained by geologists. It may have been a mere deflection of the great south-westerly current, but if so the deflection was permanent. Its great depth—about 2,000 feet from the bottom of Seneca Lake to the top of the highlands on either side, to say nothing of the mass upon their summits—must have greatly influenced its retrograde movement ; and it is therefore possible that it may have blocked the entrance to the St. Lawrence and thus have held back the waters which formed some of the ancient lake regions. The last of these ridges is 200 feet above the present level of the lake, and terminates in the vicinity of Great Sodus Bay. East of this point, the valleys were too deep to admit of a continuous beach being formed ; hence all the higher hills were islands, and the waters circulated freely through the valleys, depositing brick-clays in many of them. [A line of elevations was given illustrating these points.] There are, however, no fossils in these clays, showing that the water was very cold and not far distant from ice—doubtless the foot of the retreating glacier.

The writer quoted from Hitchcock (*Pop. Science Monthly*, Dec. 1881,) and Newberry (Geological Survey of Ohio, Vol. II.) in reference to the motion of the ice, etc., in the lake region ; and from Geikie (" The Great Ice Age"), in explanation of the causes operating to produce the peculiar arrangement of the hills. The latter author describes such hills as occurring in broad valleys in Scotland, and believes that they are formed underneath the glaciers by alternations of lateral pressure. In the region under consideration there was a broad shallow valley, as shown by the depression in the Medina sandstone, and there must have been great and striking alternations of pressure, at least

toward the close of the period of advancement of the ice, due to the stream being forced into the deep and narrow valleys of Seneca and Cayuga—alternations of pressure which must have been felt throughout the mass for some distance northward.

DISCUSSION.

Dr. NEWBERRY expressed his opinion of the great value and importance of the observations thus given, in a region that has been much discussed and yet but little understood.

Prof. D. S. MARTIN inquired whether the direction and position of Oneida Lake would not bring it into the series of radiating lake-basins mentioned by Dr. Johnson, as the most easterly member thereof.

Dr. JOHNSON replied that while its general course would correspond with such a view, yet that the basin of Oneida Lake is so different, in its shallow character, from the others to which he had referred, that he regarded it as not related to them geologically.

Dr. J. S. NEWBERRY then read the following paper:

HYPOTHETICAL HIGH TIDES, AS AGENTS OF GEOLOGICAL CHANGE.

Prof. Robert Ball, of Dublin, has recently delivered a novel and interesting lecture, with the poetical title "A Glimpse through the Corridors of Time," in which he advances a theory in regard to the agency of the tides in producing changes on the earth's surface, which is so discordant with the facts observed and the conclusions adopted by geologists, that it would seem to call for some notice from them.

In this lecture, the views of Mr. George Darwin, in regard to the history of our telluric system, are accepted, and it is claimed that the moon was at one time a part of the earth, but that while the latter was imperfectly consolidated, it was thrown off by the preponderance of the centrifugal over the centripetal force. After the separation, according to Prof. Ball, the earth and moon revolved simultaneously around a common axis once in three hours. Since that time, the moon has been gradually receding, and lagging behind in its rotation, until it is now 240,000 miles away, and revolves but once while the earth makes twenty-seven revolutions of twenty-four hours each.

The special purpose of the lecture was the announcement of the discovery of a new agency in geological change, and one represented to be of transcendent power, viz., ancient high tides. At the present time, with the moon 240,000 miles distant, its attraction produces a tide reaching sometimes, as in the Bay of Fundy, a height of sixty feet, a tide which, in its ebb and flow, causes a considerable amount of change in the land, washing away banks and cliffs, and transporting to sea great quantities of detrital matter.

Prof. Ball asserts that at certain times in the recession of the moon

from the earth, and after the cooling of the globe had produced the precipitation and accumulation of ocean waters, the attraction of the moon acting inversely as the cube of the distance, produced tides of stupendous altitude as compared with any now witnessed. For example, supposing the earth to have been largely covered with water, when the moon was 40,000 miles away, one sixth of its present distance, its attraction must have been thirty-six times as great as at present, and its efficiency as a tide-producer two hundred and sixteen times as great as at present. This would give, for an average tide corresponding to a tide of three feet now, a height of 648 feet.

Prof. Ball pictures to his audience the effect of a tidal wave of this height rushing over and retreating from all shores twice in each short day, and justly ascribes enormous destructive power to such an agent. This condition of things he fancies to have existed forty or fifty millions of years ago, perhaps when the first sedimentary rocks now known, the old Palæozoic and Archæan strata, were deposited; and since in certain localities there were accumulations of mechanical sediments, shales, sandstones, etc., to the depth of several miles in these ages, they are explained to be the result of the action of these tremendous tides.

Prof. Ball further ascribes to this agent the greater part of the changes that have taken place on the earth's surface, and claims to have revealed to geologists in this discovery the most important factor in all their data for writing the ancient history of the globe, and one of which they seem to have been strangely ignorant.

Now, all this is exceedingly interesting, and important, *if true*; but in behalf of the geologists, I venture to report certain facts which seem to be quite irreconcilable with it. There can be no question that a tide of 600 to 1000 feet in height, sweeping over all shores and lowlands twice a day, would be a most powerful destructive and creative engine; and it may be conceded at once that its potency in remodeling the earth's surface would far surpass any agent of change now in action.

Let us imagine for a moment what the effect of a tide two hundred times greater than the present would be, if called into existence on the Atlantic coast of America to-day. The height of the tide along our coast varies from nine to twelve feet, and we may say the average is ten. This would give a height of two thousand feet to the tide produced by the moon if only 40,000 miles distant. The effect of such a flood would be so tremendous that it can hardly be realized. The whole littoral plain, two hundred miles wide, which forms the topographical margin of the continent, now half sub-marine, half sub-aerial, would be swept twice a day with a wave not less than a thousand feet in height; and a bore fifty times as high as that of the Hoogly would rush up the

Hudson and Mohawk, and sweep the valley of the Mississippi to the basin of the Great Lakes. Rocks would be torn from their beds, and with all loose material, boulders, gravel, sand and clay, would be swept to and fro with overwhelming violence, and finally be spread far out over the bottom of the adjacent ocean. All this broad littoral zone, now crowded with life, and the scene of greater vital activity than any other equal area above or below the ocean level, would become at once a howling wilderness, where nature's forces waged perpetual war, and life would be impossible.

So on all other shores, the physical and vital changes would be immeasurable. Erosion would be carried on with such energy that soon all continents would be worn away, all mountains be transported into the sea. All coral reefs, all sea-weeds, and indeed nine-tenths of all the life on the globe, would, however, be swept out of existence before that time. Half the land of the globe would be submerged and desolated, and, with the destruction of the marine and the restriction to narrow limits of terrestrial vegetation, the pabulum of animal life would be so much reduced that the globe would be practically depopulated.

It may also be said that if, as we suppose, the precipitation of ocean waters took place before the corrugations of the ear h's surface had assumed any considerable magnitude, and it was r early or quite covered with water, tidal waves 500 feet or more in he ght, sweeping over the globe in rapid succession, would have worn away the emerging land as fast as it appeared, would have prevented the formation of continents and have precluded the existence of land animals or plants.

From these facts, it will be seen that if such tides had been at any time in existence on the earth's surface, traces of their action would be universal and indisputable.

Having studied with some care the geological record in places where it is as nearly complete as anywhere, I must say that I not only fail to find any proof of the existence of these stupendous tides pictured to the imagination by Prof. Ball, but, on the contrary, the whole of that record, from the Archæan to the Tertiary, offers abundant and conclusive evidence against such a theory.

As to what took place before the deposition of the Laurentian strata, we can have no knowledge, because they are the oldest known rocks yet the era of their deposition can hardly have been less than twenty or thirty millions of years ago. Though much changed from their original condition as aqueous sediments, we are yet able to recognize in them the prototypes of the sandstones, shales and limestones of later formations, and we may fairly conclude that they were deposited under like conditions. In the gneiss and granite of the Laurentian we have representatives of the coarser sediments formed along shores ; the slates are the

clays of ancient times, the deposits of quiet waters off-shore; while the marbles, which in some places form a considerable portion of the Laurentian series, are undoubtedly organic sediments that accumulated in relatively deep and quiet water by the slow process of growth and decay of animal structures. Thus the slates and the limestones are records of long continuance of quiet times and the absence of great high tides. Even the gneisses and granites are strata which must have been very different from such as would be formed by the impetuous rush to and fro, over the ocean's shores, of a semi-diurnal wave hundreds of feet in height.

The Huronian series, which follows the Laurentian, consists mainly of slates, sometimes beautifully ripple-marked, and of beds of iron ore —all shore and shallow-water deposits, but speaking of quiet times and no high tides.

The Cambrian rocks are but imperfectly shown on this continent, but they are all fine mechanical sediments, or earthy limestones, often fossiliferous, deposited along the Laurentian shore, but with an absence of all coarse material and cross-bedding, such as would be produced by rapid currents or violent ebbs and flows.

In the Silurian series, which is here remarkably complete, we have a record that tells with great clearness the physical, as well as the vital, history of the continent at that age. The Potsdam sandstone is an old beach spread over large areas of pre-existent land by a slow and quiet subsidence and an invasion of the Lower Silurian sea. The Laurentian highlands, the Adirondacks, etc., formed the shores of that sea, and the Silurian rocks were deposited in it. We know with considerable accuracy the boundaries of this sea, and can trace its shore line for a thousand miles as easily as we can that of the present Atlantic coast, and can study the littoral phenomena as satisfactorily. On the old beach, as on the new, gentle zephyrs covered the shelving bottom with ripple-marks; the stems and fronds of sea-weeds are in places thickly interlaced, the beach-loving brachiopods strewed the shore with their whole or broken shells, and the boring annelids pierced the sand with innumerable holes. This automatic and indisputable record is so clear and simple that a child may read it, and it tells in unmistakable language that in the beginning of the Lower Silurian age the littoral conditions were essentially the same as now, and that no high tides such as we have been considering could possibly have swept these shores.

Above the Potsdam sandstone is spread a sheet of organic sediments —the great Trenton limestone group—in places a thousand feet thick, composed almost entirely of the hard parts of animals which inhabited the sea. These accumulated slowly age after age, in water so quiet

that the most delicate marine organisms are beautifully preserved. In places the Trenton limestones abut directly against the Laurentian cliffs which formed the shore, and which suffered so little wear that they contributed scarcely anything to the organic sediment deposited at their base. This record hardly requires translation to be understood by all, and its antagonism to the proposed theory is apparent and irreconcilable.

Toward the close of the Lower Silurian age, the sea slowly retreated from the land it had before invaded, forming wide areas of shallow water in which grew countless numbers of sea-weeds and delicate graptolites, the carbonaceous matter of which, mingling with a fine wash from the land, produced the bituminous clays which we now call the Utica slate. It is evident that the organisms which supplied the combustible matter of this deposit could only have lived in quiet lagoon-like bays, and their presence and product, with the fineness of the inorganic sediment, are incompatible with Prof. Ball's theory.

Similar phenomena teach the same lesson in the records of the Devonian, Carboniferous, and later geological ages. In the Devonian rocks we have another and apparently conclusive argument against extraordinarily high tides, for here are coral reefs, rivaling in extent those of the tropics at the present day. Now unless the reef-building polyps were formerly altogether different in habit from those now living, these coral reefs must have been formed in water not exceeding two hundred feet of average depth and not subject to great oscillations of level. High tides would now effect the rapid destruction of the whole race of reef-building animals; at the ebb exposing them to the air and sun for hours, and at the flood burying them too deeply for their continued existence.

The abundant sea-weeds buried in the rocks of the Palæozoic and later ages, offer an equally strong argument against the high-tide theory. Nearly all the sea-weeds now living in our oceans occupy the immediate shore, and chiefly grow within a depth of from 50 to 100 feet from high-water mark. It is easy to see that if the present oceans were affected by a movement like that described by Prof. Ball, the zone the sea-weeds occupy would be the scene of the greatest mechanical violence, and they would be alternately left to dry in the sun, or be torn with resistless force from their anchorage and scattered over the land washed by the flood tide. On every old beach, however, of which we find so many in the geological series, the casts of the fronds and stems of sea-weeds are as plainly discernible as on our present shores.

In view of these facts, and others of similar import which might be cited, we are compelled to reject this theory of high tides, at least for the interval which separates us from the beginning of the Laurentian

age; in other words for the entire reach of geological history; and we are compelled to infer that either the astronomers are mistaken in their views of the genesis of the moon, and that she never formed part of the earth's mass, or that her separation and recession to near her present distance took place before the beginning of geological history. Certainly so much of the geological record as is now submitted to our inspection, offers no evidence in confirmation of, but much that is diametrically opposed to, this high-tide speculation.

COLUMBIA COLLEGE, NEW YORK, *January 2nd*, 1882.

MR. WM. EARL HIDDEN exhibited a remarkable and perhaps unique stone implement from North Carolina. Its form is that of a parallelogram of nearly a foot in length, and five inches in breadth. The lower face is slightly convex from end to end, and its upper face rises into a conical or pestle-shaped handle, some six inches high, at about the center. Dr. Newberry had suggested that its probable use was as a corn-muller. The specimen was plowed up in a field near Waynesville, Haywood Co., N. C., some three years ago, and has been in Mr. Hidden's cabinet for over a year. The material is a very compact gneiss.

THE PRESIDENT remarked further on this very singular implement, and repeated his belief that it was probably used to grind corn, upon a flat or concave stone, making comparison of it with other forms of mullers, etc., known to us from various parts of America.

He also laid before the Academy some of the advance plates of the Palæontology of New York, prepared for the forthcoming volume by Professor Hall, and spoke of the great importance of a proper appropriation by the Legislature for the completion of this noble monument to American science. There was danger that much of this carefully prepared material might fail of publication, and be lost to science, by a mistaken and unworthy policy of "economy," and he suggested that the Academy might, with great propriety, memorialize the Legislature on this subject.

Other remarks were made, in the same spirit; and it was voted that the President and Secretary be constituted a committee to express the views of the Academy in the direction indicated.

January 16th, 1882.

SECTION OF PHYSICS AND ASTRONOMY.

The President, Dr. NEWBERRY, in the Chair.

Twenty-seven persons present.

Prof. JOHN K. REES read the following paper:

THE INTERNATIONAL TIME-SYSTEM.

For the past thirty years, observatories situated in different parts of the world have undertaken to "give time" to their adjoining sections of country, by the use of the electric telegraph.[1]

At this present moment, prominent places in England and Scotland receive their time-signals from the Royal Observatory at Greenwich. There is but one standard time for the island, viz., the Greenwich time —Ireland probably gets her time from the Observatory at Dublin.

In Paris the Observatory clock controls by electricity many secondary clocks of fine workmanship distributed throughout the city.

There is also in Paris another system for distributing time, viz., the Pneumatic system. Dials in private houses, on the streets, etc., are connected by pipes with a central reservoir containing air. From this reservoir, by proper mechanism, is sent every minute an impulse, which, compressing the air in the pipes, moves the minute-hand of each dial forward one minute-space. The system has met with great popular success on account of its cheapness. It is to be said, however, that the time required for the impulse to travel from the reservoir to any dial is appreciable, and varies with the distance of the dial from the central reservoir. Some of the dials are therefore ten to twenty seconds slower than dials near the impulse-generator.[2] From many other observatories in Europe radiate time-systems of greater or less extent.

In our own country, the observatories at Washington, Cincinnati, Cambridge, Albany and New York, began about twenty-five years ago to furnish time to railroads, jewelers and government offices. The demand for accurate time has increased each year, until now we find many widely extended systems. The most important of these time-distributing centres are as follows:

1. The Naval Observatory System of Washington, D. C. This system drops a noon-time ball in Washington, furnishes time to the government and city offices, and to the railroads. The Observatory clock can be connected with the wires of the Western Union Company, so that time-signals can be sent to any part of the United States.[3]

2. The Harvard Observatory System, Cambridge, Mass. This supplies time to many business houses in Boston, drops a noon-time ball from the roof of the Equitable Life Insurance Company's building, and furnishes all the railroads entering Boston, and other roads, with clock signals.[4]

3. From Allegheny, Pa., Professor Langley sends time to Pittsburg, and also to the Pennsylvania Railroad.[5]

4. The Dudley Observatory at Albany furnishes time to Albany, and to the New York Central Railroad.[6]

5. The Observatory at Mount Lookout, near Cincinnati, supplies the city with time-signals, and several railroads get their time from the same observatory.[7]

6. The New York City system is under the control of the Western Union Telegraph Company. A noon-time ball is dropped from a pole on the roof of the company's building, and clock signals are sent to many subscribers in the city. The central clock here is regulated by time-signals received from the Naval Observatory at Washington, from Professor Langley's observatory at Allegheny, Pa., and from Harvard Observatory.

7. The Winchester Observatory (Yale College) system distributes time to the railroads and to several cities in the State of Connecticut. The State "has enacted a statute making the use of New York time compulsory upon all transportation companies within her limits."[8]

8. The Dearborn Observatory, of Chicago, is the centre of that city's time-system, and supplies several railroads with time-signals.

9. Radiating from the Observatory of Washington University, St. Louis, there is a city time-service of considerable extent.[9] Arrangements have been made to send time-signals over the railroad lines centering at St. Louis, South as far as Texas, and West probably as far as Denver.

10. The Morrison Observatory, at Glasgow, Missouri, using Western Union wires, now drops noon-time balls, at St. Louis and at Kansas City, and sends time-signals along several railroads.

These are the most prominent time-centres in the United States. But there are many other centres of less importance. From almost every public and private observatory time is sent, in one way or another, for the regulation of neighboring clocks.

Every year the demand for accurate time becomes stronger and more extended. The supply is fully equal to the demand It is possible for any business concern or private individual to obtain accurate time from some observatory near by at very small expense and trouble.

The instant of mean or clock noon, at any place, is the time when the mean sun is on the meridian of the place. It is noon then for all places on that meridian. In four and a half seconds (for lat. 40°40) it is noon for places on the meridian about one mile west of the first meridian. Places about fourteen miles west of the first meridian will have local noon one minute later, and so on.

No two places can have, astronomically speaking, the same local times unless they are on the same meridian.

In large cities, and over lines of railroads, it has long been the custom to disregard the changes in the local times as we pass to the east and to the west; and the time, say, of the City Hall is used as the standard

time for the whole city; and the time of some city on its line is employed as the standard time for railroads. The time adopted by a railroad soon becomes the standard for all cities along its line, and, shortly, local time, in its astronomical or true sense, is disregarded.

Prof. Cleveland Abbe has shown, in his report to the Metrological Society, that there are now used in this country, in operating railroads, seventy-five different standards of time. "Some of these are in error about a minute or more. Many do not differ among themselves more than one or two minutes. Some of them are furnished with uniform high accuracy by established observatories, others are furnished by jewelers employed by the railroads, and many are of very doubtful reliability."[10]

The scientific men of the country have long felt that there are too many standards, and that there is no system used in adopting them.

The subject of the "Simplification of Time Standards" was taken up in 1875 by a Committee of the American Metrological Society.

This Committee, adopting a system of Prof. Benj. Pierce, recommended (in 1879): *First.*—That the number of standards of time be diminished, and *second*, that there be no more than one standard for every hour of longitude west of the meridian of Greenwich.

The relations of the proposed standard meridians, to Greenwich (in longitude and time), to true local times of places adopting the standards, and the designation of the proposed standard times, are given in the following table:

Geographical Section.	Standard Meridian west of Greenwich	Standard Time slower than Greenwich	Standard Time slower or faster than true "local times."	Designation of proposed Standard Time.
			Min.	
Newfoundland,	60°	H. M. S. 4. 0. 0.	29 slower than St. Johns, N.F.	East'rn Time
New Brunswick,			24 faster than St. John, N. B.	
Nova Scotia,			14 faster than Halifax, N. S.	
Canada,	75°	5. 0. 0.	15 slower than Quebec.	Atlantic Time
			18 faster than Toronto.	
Maine to Florida,			16 slower than Boston.	
			3 slower than New York.	
			8 faster than Washington.	
Ohio to Alabama			19 faster than Charleston.	
			45 faster than Montgomery.	
Lower Lakes,			14 faster than Buffalo.	
			30 faster than Detroit.	
			38 faster than Cincinnati.	
Miss. Valley,	90°	6. 0. 0.	0 faster than New Orleans.	Valley Time.
Missouri Valley,			1 faster than St. Louis.	
Upper Lakes,			12 faster than St. Paul.	
			18 faster than Kansas City.	
Texas,			19 faster than Galveston.	
			10 slower than Chicago.	
Rocky Mt. Region.	105°	7. 0. 0.	0 faster than Denver.	Mount'n time
			28 faster than Salt Lake City.	
Pacific States,	120°	8. 0. 0	12 slower than San Diego.	Pacific Time
			10 faster than San Francisco.	
British Columbia,			11 faster than Olympia.	
			12 faster than Victoria.	

The section of country situated 7½ degrees on either side of a standard meridian would adopt the time of that meridian. The greatest difference necessary between the *true* local time of a place and the standard meridian would be thirty minutes. These sections of country in this latitude would be about 790 miles wide; at the equator about 1,040 miles wide. As we pass from section to section the time would change by whole hours, the the minute and second remaining the same over the whole country.

As a step in advance, it has been proposed that the railroad and telegraph companies adopt the 90° or 6-hour meridian from Greenwich, (running down the Mississippi Valley and passing through New Orleans) as their standard meridian for the whole country. This time it was proposed to call "Railroad and Telegraph Time."

In the same way it has been proposed to use the meridian through Washington. The meridian through New Orleans being more nearly a central bisecting line for the United States, and being exactly 6 hours from Greenwich, would appear to be the one best suited to the object in view.

Some parties have gone so far as to urge the adoption of one line meridian by the people generally. I can see no objection to the railroad and telegraph companies using the 6-hour meridian, provided the relation of the "R. & T." time to the adopted local time at any place is thoroughly understood. It is, however, too early to urge the acceptance of one meridian on the whole people. If we should adopt the 6-hour meridian as the standard for all local times, business and social engagements would begin at widely different times in different sections of the country. Banks would open in New York City, Boston, etc., at 9 o'clock, theatres would begin their performance at 7 P. M. In St. Louis, Chicago, etc., these same openings would occur at 10 A. M. and 8 P. M. In San Francisco the time would be 12 o'clock for bank, and 10 o'clock for theatre openings; and in like manner for other business and social engagements.

But all the systems so far spoken of are but steps toward the adoption of a uniform standard for the whole earth.

This international system was proposed independently by Hon. Sandford Fleming, Chancellor of Queen's University at Toronto, and by Prof. Cleveland Abbe of the U. S. Signal Service.

The proposed system is plainly outlined in the following

PREAMBLE AND RESOLUTION submitted to the Association for the Reform and Codification of the Law of Nations, at their meeting in August, 1881, at Cologne, in Rhine-Prussia, by President F. A. P. Barnard of Columbia College.

Whereas, Since the creation of a vast system of artificial lines of rapid transit and telegraphic communication, extending through wide differences of longitude upon both continents, great confusion in time reckoning has arisen in consequence of the use, throughout the same districts of country, of the differing times of many local meridians; and,

Whereas, The actual time in use at any place is generally arbitrary and at variance, often by many minutes, with the true local time of such place; and,

Whereas, Such differences between true and arbitrary time are in no way practically disadvantageous in the affairs of life, when universally understood and observed; and,

Whereas, It is practicable, by referring the times of all places on the globe to a limited number of meridians suitably chosen, to create a time-system for the world, so nearly uniform that the minute and the second shall everywhere the same, and the times of places widely differing in longitude shall differ only by entire hours—a system of great simplicity and likely to be conducive to the convenience of all mankind; therefore,

Resolved, That this Association approves and recommends to the favorable consideration of the governments of all nations, as well as to all scientific associations, chambers of commerce, boards of trade, and telegraphic and transportation companies, a time-system for the world, founded on the following principles:

1. Twenty-four standard meridians to be fixed upon, distant from each other fifteen degrees, or one hour each, in longitude, to which, and to which only, the arbitrary local times kept at all places on the earth's surface shall be referred.

2. The prime meridian, or that by reference to which the positions of all the remaining one-hour meridians are to be determined, to be the meridian situated in longitude one hundred and eighty degrees, or twelve hours, distant from the meridian of Greenwich, which prime meridian passes near Behring's Strait and lies almost wholly on the ocean.

3. The diurnal change of count in the monthly calendar to begin when it is midnight on this prime meridian, and the same change to take place for the several meridians successively, until the circuit of the globe has been completed from east to west.

4. The hour of the day at any place to be regulated by the standard meridian nearest such place in longitude, it being reckoned as twelve o'clock, noon, at the moment the mean sun passes such standard meridian. The minute and second to be the same at all times and for all places throughout the earth.

5. The hours of the day to be numbered from one to twenty-four without interruption, and the division of the day into two halves of twelve hours each to be abandoned.

6. For special purposes, as with a view to promote exactness in chronology and to facilitate synchronous observations in science, the day and the time of the day as determined by the prime meridian to be employed as a kind of universal time-reckoning, under the name of COSMOPOLITAN TIME.

7. For the sake of distinction, the hours of Cosmopolitan Time to be denoted by symbols and not by numbers; and preferably by the letters of the English alphabet taken in their order, which, omitting J and V, are twenty-four in number—these letters being also associated with the standard meridians in regular order from east to west, so that F corresponds to the 90° meridian passing near Calcutta, M to the Greenwich meridian of 180°, S to the meridian of New Orleans, 270°, and Z to the prime or zero meridian.

In proposing these resolutions, President Barnard made the following remarks:

* * * * * *

"The bounding lines between the successive meridians at which the count of the hour shall change, it is not proposed to define with the same geometrical precision which characterizes the meridians themselves. The idea is rather to follow any well-known natural or political divisions which fall approximately midway between the meridians, and which will serve as easily remembered reference boundaries. On the American Continent, such lines of demarcation are easily found. The States and provinces which touch the Mississippi river will use valley time; the Canadas, and the States of the Union which lie east of these valley States, and most of which touch the Atlantic, will use Atlantic time; the British provinces farther eastward will use eastern time; the States and provinces which touch the Pacific, will use Pacific time; and all those which lie between the Pacific States and the valley States will use mountain time.

The means by which we expect to establish this system on the American Continent, are partly the voluntary action of the transportation companies; partly the co-operation of municipal corporations and chambers of commerce; and partly local legislation. Already many local organizations have taken steps for the establishment of time-balls and other time-signals in furtherance of the practical introduction of the system. The State of Connecticut has enacted a statute making the use of New York time compulsory upon all transportation companies within her limits. * * * * *

The Governor-General of Canada, the Marquis of Lorne, has been

pleased to interest himself actively in promoting the success of the movement. The papers relating to it which have been published by the two associations whose titles have just been mentioned[12], have been forwarded by Lord Lorne, through the British Foreign Office in London, to countries with which Great Britain is in diplomatic relations, and to their scientific associations; and from the Imperial Academy of Sciences at St. Petersburg have been received copies of a report from a committee, of which the eminent astronomer Otto Struve was chairman, cordially approving the project; which report was adopted by the Academy.

Two or three minor features of the scheme contained in the resolutions proposed remain to be mentioned. The first of these is the proposition to abolish the present division of the day into two equal portions of twelve hours each, and to employ instead a continuous count running from one to twenty-four hours in each day. The division at present in use is not a natural one. It is founded, presumably, upon the custom of astronomers to begin the day at the meridian passage of the sun, or the habit of the people to fix the moment of apparent noon by observing the coincidence of the shadow of a vertical style with a line drawn north and south. The natural division of the day is into a light portion and a dark portion. These portions are always and everywhere unequal, except for a single day in the year, or for a single great circle of the earth—the equator. No exact system for the uniform division of time can therefore be founded upon them. On the other hand, no disadvantage can arise from regarding the day as a unit, subdivided into twenty-four equal fractions, a mode of division once very general, at least in Italy, and hardly yet entirely abandoned; while there are very appreciable disadvantages attending the present division into twelve-hour moieties. The first of these is the necessity of using always in speech the word *forenoon* or *afternoon*, in order to identify the portion of the day to which any hour which happens to be mentioned or is to be referred; or, in writing, to place after the number of the hour the explanatory suffix A. M. or P. M. Another and even greater is the uncertainty in railway time-tables as to whether a particular hour is an hour of the night or of the day. The compact form of these tables renders it impossible always to introduce the necessary specifications in their columns, and the inquirer is thus often left at a loss. Some of the tables, in order to remove the embarrassment, have employed the expedient of printing the hours of the night in white letters upon a black ground, while those of the day are printed in the usual way with black letters upon a white ground[13]; but the very adoption of this expedient is a confession of the existence of an evil which we may easily perceive to be quite unnecessary. Let the hours

of the day be only continuously numbered from beginning to end, and there will never be any uncertainty as to which part of the day is meant.

Another of the secondary features of the scheme is the designation of a zero meridian. The zero meridian is that from which terrestrial longitudes begin to be reckoned, and that at which, at the close of the day, the count of the day in the monthly calendar shall be momentarily the same for the entire globe. Any meridian which might be chosen, and which should be generally accepted, would answer for this purpose; but such a selection ought not to be made through mere idle caprice. Regard should be had to usages actually existing; and if there is any meridian which has already become more familiar than any other to the great majority of mankind, that circumstance should be counted in its favor. In a contribution made by me some ten years ago to a provisional code of international law drawn up under authority of a resolution of this Association, by the Hon. David Dudley Field, afterwards President of the Association, I endeavored to assign some reasons why the meridian of Greenwich is entitled to be regarded as rightfully the first meridian for purposes of longitude. But the same reasons apply with equal force to the inferior meridian of Greenwich--that is to say, to the meridian twelve hours distant in time, and 180 degrees distant in longitude from Greenwich itself; and as I have found, in consultation wirh others, that there might be danger of awakening national susceptibilites by insisting on Greenwich (though, for myself, I fail to find this consideration serious), I have yielded my first opinion, and propose to fix the first meridian for time and for terrestial longitude at the 180th degree from Greenwich, so that this first meridian will fall almost entirely upon the ocean. As in the monthly calendar the change of count must begin at some particular meridian, it is desirable that this change shall take place, if possible, beyond the limits of all habitable lands; and this is true of the meridian proposed, since, except a small portion of wild and desolate sub-arctic Kamschatka, it scarcely touches any portion of the earth's surface uncovered by water. At this assumed first meridian, therefore, the day in ordinary chronology will begin when the mean sun is on the meridian of Greenwich; so that in fact it will be identical with the astronomical day as reckoned at that observatory.

The last of the secondary features of the scheme which I have to notice, is the proposition to establish, for purposes of pure chronology, and for the facilitation of synchronous observations in science, a special time-reckoning under the name of *cosmopolitan time*. So long as the dimensions of the known world were limited in longitude between the Indies on the east and the Canary Islands on the west, there was no

danger of a confusion of chronology to arise from a mistake of an entire day in a date. But at the present time, and since civilization has encircled the entire globe, it is a fact that there are certain hours in every twenty-four, during which, for one entire half of the habitable world the date is a unit more advanced in the monthly calendar than in the other. The change of count must have a beginning somewhere. In the absence of any distinct convention on the subject, it is generally understood that this change begins somewhere in the Pacific Ocean. It happens, therefore, that at the moment when the sun is on the meridian opposed to that of Greenwich, the date for all Asia and all Continental Europe may be, for example, the first of January before noon, while for the entire American Continent it is still the thirty-first of December. On the other hand, when, twelve hours later, the sun is on Greenwich meridian, the date will be the first of January for all the world, but will be afternoon for Asia and Europe and forenoon for America. At present the change of count, as above observed, is supposed to begin in the Pacific Ocean, But if we are to be exact, it ought to begin at some certainly defined meridian; and the present proposition is to make it begin at the meridian distant twelve hours from Greenwich.

The time determined by the proposed zero meridian is, according to a suggestion of Mr. Fleming adopted in the resolution, to be distinguished as cosmopolitan time, and might equally be called universal or absolute time. Any observation made in cosmopolitan time will be fixed with absolute certainty both in the chronological sequence and in the hours of the day, and it can easily be converted, by the addition or subtraction of an even number of hours, into the particular time of each standard meridian. Mr. Fleming proposes, also, that the hours of this universal time shall be distinguished by symbols or letters rather than by numbers. The value of this suggestion consists in the fact that by means of it the danger will be averted of ever confounding cosmopolitan time with that of any other except the prime meridian."[14]

Delegates from the American Metrological Society and from the Canadian Institute, were sent to the International Geographical Congress held at Venice in September, 1881. These delegates laid before that Congress the above proposed International time-system. Group 1, to which the resolutions were referred, reported as follows: "The Group 1 considers and emits the vote that within a year an International Commission should be appointed by the Governments to consider the question of an Initial Meridian, having in view not only the question of longitude, but especially that of hours and dates. The Commission should be composed of scientific men such as geodesists, geographers, and men who represent the interests of commerce, etc. Three mem-

bers should be named by each nation. The President of the Italian Geographical Society is requested to take the initiative in bringing the subject before his Government and foreign geographical societies, and to take the necessary steps for the realization of the request contained in the resolutions. The Group desires to draw attention to the proposition of the American delegates that the proposed International Commission should meet at Washington on or before May 1, 1883."[15]

From what has been shown, it appears that the proposed system is being widely discussed, and is generally favorably received. Efforts have been made to bring the whole subject before the railroad men of the country. Communications were presented at the General Time Convention of all the roads in the United States, held in New York City in October, 1881, from Professor Abbe, chairman of the committee on Standard Time of the American Metrological Society, and from Professor Ormond Stone, chairman of the committee appointed by the American Association for the Advancement of Science. These communications were referred to the secretary, with directions to report at the meeting to be held in Cleveland, in April, 1882. Public opinion is being informed in regard to the proposed system. In the near future we may hope to see the adoption of the suggested standards.

Prof. D. S. MARTIN read by title the following paper, to appear in full in the forthcoming Annals of the Academy, Vol. II, Nos. 7 and 8:

DESCRIPTIONS OF NEW SPECIES OF FOSSILS FROM OHIO, WITH NOTES UPON SOME OF THE FORMATIONS IN WHICH THEY OCCUR. By Prof. R. P. WHITFIELD.

He also presented the full programme of the Academy's Lecture-course for the season, in behalf of the Committee on Lectures. The course comprises the following subjects:

January 23.—THE MORAL BEARING OF RECENT PHYSICAL THEORIES. Prof. BENJAMIN N. MARTIN.

February 20.—ANCIENT CIVILIZATIONS IN AMERICA. Prof. JOHN S. NEWBERRY.

March 20.—SOME RESULTS OF PHOTOGRAPHY AS APPLIED TO ASTRONOMY. Prof. JOHN K. REES.

April 17.—THE SUBMARINE TUNNEL BETWEEN ENGLAND AND FRANCE. Count ERNST VON HESSE-WARTEGG.

May 15.—GLACIERS. Prof. H. CARRINGTON BOLTON.

NOTES FOR "THE INTERNATIONAL TIME SYSTEM."

[1] See Proceedings of the American Metrological Society, p. 18, Vol. II., Part I. Report of Committee on Standard Time, and Vol. II., Part II., page 175.

[2] A full description of this unique system is given in the January number of the *Popular Science Monthly*, by Prof. E. Engler, of Washington University, St. Louis.

[3] See Reports of the Superintendent of the Naval Observatory, in the Washington Astronomical and Meteorological Observations.

January 23, 1882.

The President, Dr. Newberry, in the Chair.

The first of the regular monthly lectures of the course for 1882 was held in the large hall. The number in the audience was not recorded.

The President opened the course with a few brief remarks, and gave place to the lecturer of the evening, Prof. Benjamin N. Martin, of the University of the City of New York, who addressed the Academy on the following theme:

THE MORAL BEARING OF RECENT PHYSICAL THEORIES.

(ABSTRACT.)

The speaker maintained that the argument for the Divine existence from the adaptations discernible in nature has, with the recent progress of scientific ideas, undergone a great and essential modification. He quoted Paley's statement that no change takes place in an animal form from generation to generation. We do not, by running back through an indefinite series of ages, make any approach to accounting for the intelligence displayed in its construction; though if there were some slight gain at each step, we might by an indefinite series of generations, approaching nearer and nearer, account thus for the whole result.

The scientific opinion of Paley's day affirmed the fixedness of species; and, so long as that view was maintained, Paley's argument was unassailable. But now, Darwin has questioned this idea, and scientific opinion, in affirming the progressive development of species, has stricken away the foundation on which the teleological argument had

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Notes for "The International Time System."—*Continued.*

[4] See Annual Reports of the Director of the Astronomical Observatory of Harvard College.

[5] Reports of the Director of the Allegheny Observatory for 1872, *et seq.*

[6] Annals of the Dudley Observatory, 1866, *et seq.*

[7] Annual Reports of Director of Cincinnati Observatory, 1868, *es seq.*

[8] Pamphlet on "The Regulation of Time," etc. By F. A. P. Barnard, President Columbia College, New York City.

[9] Copies of St. Louis *Globe-Democrat* and St. Louis *Republican*, for January 11, 1881.

[10] See Proceedings of Am. Metrolog. Soc., Vol. II., Part I, page 24.

[11] Proc. Am. Met. Soc., Part II., Vol. II., p. 179. Standard Time-Circular No. 1.

[12] Am. Metrol. Soc. and Canadian Institute.

[13] The Penn. R.R. prints the time between 12 o'clock noon and 12 o'clock midnight with heavy faced type, besides putting in the designations A.M. and P.M.
Some of the railroads in the West have printed time-cards with the hours numbered from one to twenty-four. J. K. R.

[14] From a Pamphlet on "The Regulation of Time; International Coinage; The Unification of Weights and Measures; Sea Signals." By F. A. P. Barnard, S. T. D.

[15] Part of unpublished Report of Committee appointed to attend the Third International Geographical Congress, held at Venice, September, 1881.

been so confidently based. *Now*, what? This requires a consideration of recent scientific principles and an account of their bearing on theism.

The great results of scientific inquiry in our day are two, expressed each by a single word, EVOLUTION and CORRELATION. The first of these, evolution, is that the arrangements of nature are due, not to immediate acts of Divine creation, but to a process of slow development (1) from small beginnings, (2) by gradual changes, (3) through long periods, and (4) by the operation of natural forces.

This truth is no recent discovery of Mr. Darwin, though formulated by him in one department, but is the general characteristic of modern science. It is displayed (1st) in the great nebular hypothesis. This is simply an account of the development, through the process just described in its four particulars, of the astronomical system. Our own solar system discloses this as the method of its origin; the cosmical system illustrates the same process, and the nebulæ beyond alike suggest it. In this view all astronomers are now substantially, though with some variations, agreed.

(2d) Next: Geology manifests still more striking evidences of the same process of development. We can trace our globe downward from the condition of a fiery mass, on which water could not exist, to the formation of seas; in these the deposit of rocks—Archæan, Silurian, Devonian and the rest—took place according to the present laws of deposition; and still the process goes on to the present time, and gives us the whole body of the rocks with their elevations and depressions. In all this, geologists agree in finding the slow and gradual operation of natural forces.

Organic life is now claimed as falling under the same law; and thus we have almost the whole body of Science committed to the development theory.

This theory has two effects: 1st. It reduces all operation of creative power to a minimum; the changes at each point are insignificant: 2nd. It removes this minimum to the remotest period of time. The creative power may have formed germs, in the beginning; but for all else, the work of nature's forces will sufficiently account.

The other great scientific idea is that of the correlation or convertibilty, of the Forces.

Working in quite a different sphere, and with no relation to the progress already described, Science has given us another change of views of altogether an opposite tendency. Phenomena are no longer ascribed to "fluids," as the electric, or the caloric, fluid. They are now conceived as due to molecular motions in things around us. "Heat," says Tyndall, "is a mode of motion;" and as clearer conceptions began to dawn

upon the scientific mind, it was found that several of these groups of phenomena, which had originally constituted distinct sciences, are at bottom only varying modes of motion, occasioned by the varying conditions of action, of a single force. Magnetism, and Voltaism were found to be but variations of electricity: soon electricity began to identify itself with chemical affinity: heat and light were correlated with each other; heat, moreover, showed its relation to electricity in the phenomena of thermo-electricity. At length Faraday, with the aid of Whewell, entered upon an elaborate investigation, and showed satisfactorily that all these phenomena are due to one general and all-pervading force. All are mutually convertible: and hence we have the theory of the unification of nature, in the doctrine variously described as the Persistence of Force, and the Correlation or Convertibility of the Forces. All specific forces are simply phases of one. This one is without beginning or end, it pervades the universe; it has framed the systems of the heavens and the earth. As expounded by Herbert Spencer, it is "coördinate with all orders of phenomena;" and is the real and sole author of all the changes which take place around us—the ever present, ever active, unbeginning, and unending nature-force which carries on the working of the universe.

It results from this, that there is no real force but this of the infinite, and that every other and more specific force is but a transient phase of the acting of the First Cause.

This conception of an infinite and diffused force or power, carrying on, as it has originated, the system of nature, is the very opposite in tendency of the former. Correlation is the counterpart of Evolution. While the latter removes the creative action to the farthest limit of time, the latter brings it into the present operations of nature. While evolution reduces the divine action to a minimum, correlation makes it the only active and vital thing in nature; while evolution attributes everything to physical forces in all the bodies of the world, correlation abolishes the very existence of these forces as distinct realities, and makes the infinite the only real agency—the ever active cause of all nature's changes. We are, therefore, brought—by this doctrine of correlation—face to face with the infinite and the eternal.

It is the most elementary doctrine of physics that every action involves an equal reaction. When, then, you act, what force is it that reacts against you? Whatever may be its humble name, or its familiar aspect, it is simply the force of the infinite.

To some, this may seem to involve the danger of Pantheism; but we are shut up to it, whatever the danger. It only brings us back, however, to the familiar conception of Newton, that "the laws of Nature are the established methods of the Divine action;" and Newton

was no Pantheist. The doctrine of "the convertibility of the forces," or, as others have preferred to state it, "the persistence of force," gives us a single infinite force as the life of the world; and this necessarily identifies itself with what the Christian calls God.

Spencer, indeed, maintains that we cannot know the infinite; but he himself calls it "the First Cause;" declares it is the vital agency in every change, and proclaims it "productive," and shows thus a clear knowledge of it in the weightiest possible relations.

Tyndall hesitates to speak thus plainly, and says: "I will not call him, or it, a cause or a power;" but silence is not philosophy. If there is this single and universal agency, the consequence follows that all nature's movement is due to this one great cause, which originally shaped the earth and formed the heavens.

Correlation lays the foundation for a belief in the theistic conception. We have but to prove the intelligence, and the moral and personal character of this infinite cause, and we have before us what Christ called the "Lord of heaven and earth;" and this, the familiar argument of Paley, and the rest of our teleological writers, enables us to do triumphantly.

In view of this great generalization, of one only force in the universe, the whole perplexing and obscuring maze of second causes and minor forces disappears—we are face to face with the infinite, with which alone we have to do. Thus, while Evolution seems almost to banish God from the creation, the profounder philosophy of Correlation restores this grand conception, and makes us feel that in very truth it is in the First Cause that "we live, and move, and have our being."

January 30th, 1882.

Section of Geology and Mineralogy.

The President, Dr. Newberry, in the chair.

Fifty-seven persons present.

The committee, consisting of the President and Recording Secretary, to whom had been referred the preparation of a memorial to the authorities of the State, regarding the completion of the volumes of the Geological Survey, reported the following resolutions, which were unanimously adopted by the Academy.

Whereas, A large amount of new and valuable material has been prepared by Prof. James Hall for the completion of his series of reports on the Palæontology of New York, many of the plates having been already engraved; and,

Whereas, The publication of this material would require only a rela-

tively small appropriation, and would give to the public the fruit of large expenditures previously made,—is demanded by the honor of the State,—and would greatly facilitate the labors of every geologist in the country;—

It is therefore,

Resolved, That the best interests of the State of New York, and the credit and usefulness of science in America, would be advanced by the completion of the great work on the Palæontology of New York, continued through so many years under the supervision of Prof. James Hall; and,

Resolved, That the members of the State Legislature be, and hereby are, earnestly requested to make the necessary appropriations for the publication of the material already prepared, while it may have the benefit of the supervision of the distinguished palæontologist who has been the author of the preceding volumes; and,

Resolved, That a copy of these resolutions, signed by the President and Secretary of the Academy, be transmitted to the Governor of the State, and to the presiding officers of the Senate and Assembly.

O. P. HUBBARD. J. S. NEWBERRY.
Rec. Secretary. *President.*

THE PRESIDENT read a letter from MR. CHARLES W. LOVETT, of Centre Marshfield, Mass., regarding the rate of accumulation of salt-marsh deposits in eastern Massachusetts. At various points in his vicinity, MR. LOVETT reports the finding of bricks identical with those used for the chimney of the old Peregrine White house, buried beneath three feet of compact undisturbed marsh-soil. Wood cut by the civilized axe, and other articles, he also mentions as found at the same depth, and in like situations. The rate of growth seems to be general, and not local or accidental; and some clue may thus be gained as to the movement of the coast-level in this region.

DR. ALBERT R. LEEDS gave a brief account of the methods of formation and the properties of a number of new componnds of the organic aromatic bases, with the haloid and other salts of the metals. The resulting compounds are substances formed on the ammonium type, with as many hydrogen atoms replaced as would correspond with the valences of the metallic radical entering into combination. When certain of these compounds, such as the Di-phenyl-mercurammonium chloride, or cyanide, or the Di-tolyl-mercurammonium cyanide, are exposed, along with carbon bisulphide, to the action of sun-light or of heat, part of the sulphur in the carbon bisulphide unites with the metallic radical, hydrochloric or hydrocyanic acid is evolved, and Di-phenyl-sulpho-carbamide or Di-tolyl-sulpho-carbamide is formed.

MR. WM. EARL HIDDEN then read the following paper:

THE DISCOVERY OF EMERALDS IN NORTH CAROLINA.

Mr. President, Ladies and Gentlemen:

That emeralds have been found in the United States, has been doubted. The press has stated "the discovery of emeralds needed confirmation." It is my pleasure to show you this evening convincing proof of the existence in our country of this rare and beautiful gem. Since what the impetus was that started the search for emeralds in North Carolina would be of interest, I will give you the story, gathered as it is from a year's residence on the spot where the discovery was made.

Sixteen years ago, the site of the North Carolina emerald mine was covered with a dense primitive forest. Less than ten years ago the locality was mineralogically a blank, nothing was known to exist having any special interest or value. Whatever we know of it to-day, is due indirectly to MR. J. A. STEPHENSON, a native of the country, whose interest in mineralogy is a purely natural one.

Under a promise of reward, if successful, he had engaged the farmers to search the soil for crystals, Indian stone relics, etc., and for some years enjoyed surprising success in thus gathering specimens.

Every specimen found in this region proves to be a revelation to science. In some respects they were of more interest than anything heretofore found of their kind.

Certain it is that this region, and I state this from my own experience in collecting, has produced some of the most remarkable and beautiful specimens of Emerald, Spodumene, Beryl, Rutile and Monazite, thus far discovered in the United States.

To be brief and to the point, I will say, that in a few localities in Alexander county, crystals would be brought of the common opaque beryl; but now and then a semi-transparent prism, having a decided grass-green color, much resembling the famous crystals from Siberia, so familiar to mineralogists, would be found and offered for sale in the neighboring towns. Those came to have the name among the farmers of "green rocks" and "green bolts." From the fact of their selling for more than anything else they found, these green crystals became the ultimatum of their searching.

Among other curious local names for minerals were "Donicks" for quartz crystals, "Black Bolts" for prisms of tourmaline, "Red Metal" for rutile crystals, and "Needle Rock" for the beautiful sagenite, or Arrows-of-love stone.

Suffice it to say that in a period of about six years, there were found loose in the surface soil, on three plantations in this county, a small

number of beryls having a color verging distinctly upon the true emerald tint, none of which crystals, however, were deep-colored or transparent enough for use as gems.

Some of these crystals were obtained by the Mr. Stephenson before mentioned. It was the sight of two of these "green bolts" which prompted me to visit the locality and make a search for the true emerald. I cannot understand why work was not commenced long ago, when such favorable signs were so common.

That such indications could receive only passing notice from collectors, is really inexplicable. A very natural conclusion would have been that where these pale emeralds were found loose in the soil, darker and purer ones would be found by mining for them.

Such inducements as the following were held out to the farmers to search for these "green bolts." A visiting collector had offered the munificent sum of *one dollar*, to farmers who should find a crystal as long as his finger, which must, to merit the dollar, be *dark green*, pure, transparent, and with perfect terminal planes and prismatic faces!

Such is the history of the emeralds found in Alexander county, before I commenced systematic mining for them.

The location of the mine was obtained in the following manner. A corps of workmen was employed to dig a series of deep ditches in directions that would cut the strata at different angles. The site chosen for work was on the spot where at least half a dozen pale emeralds had been found. This location was shown to me by the farmer who had discovered the specimens while plowing.

Not knowing then their manner of occurrence, I expected in this way to strike a vein bearing them. Five weeks were spent (in July and August, 1880) before any success was met with; and then, at a depth of eight feet was discovered a "blind vein" (so called because it had no outcrop), having very small emeralds. In this vein, or pocket, as it proved to be later, and outnumbering the emeralds fifty to one, was also found the new emerald-green mineral which was such a surprise to the scientific world, and which was destined to answer the same purposes as did the gem I sought. I refer to the spodumene-emerald, now known as Hiddenite.

You must pardon this digression, but the search for emeralds is so interwoven with my discovery of emerald-green spodumene that I cannot tell the story of one without the other. The two minerals occur intimately associated, and while mining for the one the other is constantly found.

This blind vein yielded very handsomely of the new mineral, but very sparingly of emeralds, and the few found were too small to be useful as gems, though their color was very good. A tunnel, for

the purpose of drainage, 261 feet long, mostly through rock, was cut to this vein, and a shaft sunk down upon it. At this time the work on this vein has reached a depth of 36 feet, at which point it proved its pocket nature by pinching out—closing together.

Thus far, twelve of these pockets have been found within an area of forty feet square, carrying emeralds, four of which pockets contained also the spodumene-emerald.

All these veins maintained nearly the same character of dip, thickness, length and associations.

Other pockets were found that yielded Quartz, Rutile, Monazite, and Mica crystals of great beauty. Others yet, whose walls were covered with finely crystallized Dolomite, Calcite, Apatite (transparent and pellucid) Rutile, Pyrite, Quartz and Mica.

In one instance, a small pocket that contained two beautiful emerald crystals, had its walls covered with large crystals of Albite (twinned parallel to the basal plane). Another pocket contained only Mica crystals and one small pellucid colorless beryl that had both ends brilliantly terminated with many planes. I mention the above associations, that you may learn the diversity in these pockets, although they are so near together.

In the rock-mining, and while prospecting on the surface, the sign of a vein is the presence of small streaks of massive quartz, or of mica, in a counter direction to the strike of the country-rock, either of which lead to open pockets not many feet off. The gems have thus far been found loosely attached to the rock. Not over nine emeralds have been found at any one time. Mineralogists have a great treat in store for them, when deep rock-mining is accomplished here. Then the gems will be found firmly attached, and they will shine with all their primitive crystalline beauty.

The largest emerald found in this mine is 8½ inches long, and weighs nearly 9 ounces. It was one of nine fine crystals contained in a single pocket; their color was excellent, and they were transparent, though somewhat flawed.

The locality is situated about 35 miles, air-line measure, S. E. from the "Blue Ridge" mountains. The contour of the country is low rolling, and its altitude is about 1200 feet. The soils are chiefly red gravelly clays, of not much fertility. The prevailing rock is gneiss, with more of a feldspathic than a micaceous character: the trend of the strata is N. N. W. and S. S. E. with a dip nearly vertical.

The gems and crystals occur in open pockets (miniature caves), of very limited extent, these are cross fractures or fissures in the rock. These fissures, lenticular in shape, are usually nearly perpendicular.

There being no glacial drift here, the soils are necessarily the result

of decomposition and disintegration on the spot. It is therefore an easy task to find the source of minerals found on the surface. The "*frost drift*" theory of Prof. Kerr is everywhere proven in this region. He well says that "to a foreign geologist, entering the South Atlantic States for the first time, a hundred miles or more from the coast, the most striking and novel feature of the geology is the great depth of earth that everywhere *mantles and conceals the rocks.* This is readily discovered to be, for the most part, merely the result of the decomposition *in situ* of the exposed edges of the underlying strata. The vertical and highly inclined bedding-lines of strata, *are distinctly traceable by the eye, through this superficial earth covering, and are seen to pass by insensible gradations into the undecayed rock beneath.*" At this locality, the unaltered rock is found at a depth of twenty-six feet, and is of unusual hardness, especially where it walls the gem-bearing pockets.

Thus far the gems have been found in a narrow belt running N. E. and S. W., and scattered over a distance of three miles. In this belt, signs of cross-fissures are very abundant, and it is a very common thing to find crystals of quartz, rutile, tourmaline, etc., etc., *perfectly preserved*, scattered over the surface.

A peculiar feature pertains to most of the emeralds and beryls from this region. They appear as though filed across the prismatic faces. The basal plane is also often pitted with minute depressed hexagonal pyramids, that lie with their edges parallel to one another, and to the edge of the di-hexagonal prism. Rarely, though, crystals are found with perfectly smooth and brilliant faces. The emerald color is often focused on the surface, and fades gradually to a colorless central core, which feature is of exceeding interest when the genesis of the mineral is considered. The emeralds have been found of richer color, and less flawed, as the mine gets deeper. [These points were illustrated by a beautiful series of specimens.]

In regard to the commercial value of the emeralds thus far found, I will frankly state that the majority of the crystals have little value for gem purposes; but as cabinet specimens they are unprecedented, and as such have a market value ranging from $25 to $1,000 each.

From the largest crystals, stones of over one carat weight could be cut, that would be marketable as gems; but as scientific specimens, the crystals in their entirety would have greater value. Certainly no better signs could be wished for than these specimens, to prove the existence at this locality of dark-colored crystals, pure enough for cutting into valuable gems.

This region has a great future as a gem-producing district. Mining skill and capital are the only essentials needed to insure success. It may be interesting to note that the entire expense of the work at this

locality has been more than repaid by the sales of the gems (Hiddenites) discovered. But for the liberal financial aid given to the writer by both MR. RICHARD H. ROBERTS, of Albany, and MR. JAMES D. YERRINGTON, of Cresskill, N. J., the work of discovery and development at this locality would have been very much retarded, if not indefinitely postponed.

DISCUSSION.

DR. NEWBERRY remarked on the extreme beauty of the specimens exhibited by MR. HIDDEN, and the great interest of these discoveries, in which he had achieved such signal success, both practical and scientific.

DR. R. P. STEVENS made some further remarks on the communication, comparing the aspect of the specimens, and the mode of their occurrence, with those of the emeralds from the celebrated locality near Bogota. He referred to the fact, also, that the Bogota mines had been worked by the early aborigines, and were doubtless the source of the emeralds described with so much enthusiasm by the Spanish historians of the conquest of Peru.

MR. GEORGE F. KUNZ exhibited a remarkable series of prehistoric knives, flakes, and cores, of Obsidian, from the vicinity of the city of Guatemala, Central America. They were obtained by the partial cutting away of a mound, during the making of a new road, about six miles from the city. The excavation revealed a sort of little cyst or chamber, walled and roofed with slabs of stone or baked clay, within which this large quantity of obsidian knives had been carefully and quite regularly laid away. There was scarcely anything else in the chamber, but the broken and worn edges of many of the implements would indicate that they had been much used; and the suggestion is strong that this may have been a sacrificial mound, and that these were the implements used in the rites of sacrifice, perhaps for a long period.

locality has been more than repaid by the sales of the gems (Hiddenites) discovered. But for the liberal financial aid given to the writer by both Mr. RICHARD H. ROBERTS, of Albany, and Mr. JAMES D. YERRINGTON, of Cresskill, N. J., the work of discovery and development at this locality would have been very much retarded, if not indefinitely postponed.

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Feb. 6, 1882.

REGULAR BUSINESS MEETING.

The President, Dr. J. S. NEWBERRY, in the Chair.

Forty-five persons present.

The following named gentlemen, on recommendation of the Council, were elected resident members:

A. D. CHURCHILL. JOHN TOWNSEND.

The Committee appointed at a previous meeting, to prepare resolutions appropriate to the recent death of Dr. J. W. DRAPER,

reported the following minute, which was read by Prof. D. S. MARTIN:

WHEREAS, The recent death of Prof. John W. Draper has removed from among us one of the oldest and most distinguished members of the Academy, and one of the most eminent original investigators in the realm of physical science, therefore.

Resolved, That the Academy would hereby express its profound appreciation of the high attainments and honorable services of our late associate, and its sense of sorrow and loss in his departure from our sphere; and that we cannot suffer this event to pass without a brief tribute to his revered and cherished memory.

Prof. John William Draper was born in 1811, at St. Helens, near Liverpool, England. Having received a thorough preliminary education, he was sent to the newly-opened London University, in 1829, that he might study chemistry under Dr. Turner. Urged by relations, he came to America in 1833, and soon afterwards began the study of medicine at the University of Pennsylvania, from which he was graduated in 1836.

Immediately after his graduation, Dr. Draper went to Hampden Sidney College, as Professor of Chemistry and Physiology, to which chair he had been elected before receiving his degree. There he began that remarkable series of investigations which ended only with his life, and which has had so important a bearing on the progress of discovery in several branches of physics. The results of his earlier researches were published in the *American Journal of Science* and in the *London Philosophical Journal;* and, together with later discussions, were collected into one quarto volume, which was published in 1844, under the general title of *The Chemistry of Plants.*

The interest awakened by these earlier investigations secured for Dr. Draper the appointment of Professor of Chemistry and Physiology in the University of the City of New York. He was originally assigned to a chair in the Medical Department, but owing to the financial disaster of 1837, the Medical School was not organized at once, and Dr. Draper began his work in the Collegiate Department of the University, in 1839. He remained in the discharge of his duties until within a few months of his death.

To Dr. Draper is due, in a great measure, the prominence of New York City as a centre of medical education. Previous to 1840, the number of students attending the Medical School seldom exceeded fifty, and oftener fell below. But in that year the Medical Department of the University was organized, and under the management of Dr. Draper, as Secretary of the Faculty, classes of almost 150 students

were graduated. The existence of the school was imperiled in 1865, when fire destroyed its building, with the museum and apparatus; but Dr. Draper succeeded in obtaining temporary accommodations, and the exercises went on without the loss of a single day. Dr. Mott resigned the Presidency of the Medical Faculty in 1850, and was succeeded by Dr. Draper, who retained the position until 1873, when he resigned it in order to devote himself wholly to his duties in the Collegiate Department.

Dr. Draper's lectures on physiology were as eloquent as they were original, and reflected well his daily work as an investigator. They were published in 1856 as a *Treatise on Human Physiology*, which was recognized at once as a substantial contribution to the rapidly developing science of which it treated. This work was the record of observations covering more than twenty years.

The *History of the Intellectual Development of Europe* was but the outgrowth of the work on physiology—a grand expanding of its second portion. It is familiar to most of us, and needs neither description nor discussion here. Soon after the publication of this work, Dr. Draper began the preparation of a *History of the Civil War in America*, which was published in three large volumes. During its preparation he enjoyed exceptional advantages.

After completing the *History of the Civil War*, Dr. Draper returned to those physical studies of which the continuity had been interrupted by his literary labors. During the last ten years of his life he revised his earlier publications, and gave them in condensed form under the title of *Scientific Memoirs*. In these he included also the results of investigations conducted during the preparation of this volume, some of which were of cardinal importance.

It would be difficult to over-estimate the value of Dr. Draper's labors, which are interwoven with the progress of scientific discovery during the last forty years. He was the first to take the human portrait by light, and he was the first to discover and to photograph the lines below the red in the spectrum. He laid the foundation on which Bunsen and Kirchoff reared a noble superstructure, without much regard to the master builder who had preceded them in the work. Of his discoveries in physiology, the most important were made so long ago that they have now become incorporated into the science so fully that the name of the discoverer is rarely mentioned in connection with them.

This Academy should hold the memory of Dr. Draper dear to it. Soon after reaching New York he became an active member of the Academy, then the Lyceum of Natural History. Many of his earlier results were first announced in its meetings, and the proofs of his dis-

coveries were deposited in its collections. When misfortune overtook the Lyceum, when it was deprived of a shelter for its collections and was without a place for its meetings, and when most of its members were ready to desert the organization or to dissolve it, Dr. Draper procured for the Society the privilege of depositing its collections in the building of the University Medical School, and of holding its meetings in the faculty-room of the same building. It may be said that the continued existence of the Lyceum was due solely to Dr. Draper's efforts in that crisis of its history.

Dr. Draper was a diligent student in many fields of research. The great fund of knowledge thus acquired made him rich in illustration, and gave to his writings an eloquence peculiarly his own. He was an ingenious and persistent investigator, with an acuteness of perception which rarely failed to grasp the bearings of facts. He was an earnest and patient instructor, full of a magnetism which attached his pupils to him and awakened an interest in the science which he taught. He was unassuming in manner, but possessed of an indomitable will, and was actuated by a delicate sense of honor in all dealings with his fellow men.

Dr. Draper is gone from among us, but his works will survive him. The field of investigation in which he stood almost alone, forty-five years ago, has now many devoted workers, through whom each year will bring fresh additions to his fame.

Resolved, That this minute be published in the Transactions of the Academy.

JNO. J. STEVENSON, } *Committee.*
DANIEL S. MARTIN, }

The resolutions, as read, were unanimously adopted by the Academy.

Notice was given to the Society of the death, since the last meeeting, of Dr. A. L. HOLLEY, one of its Fellows; and, on motion of Mr. ARTHUR H. ELLIOTT, that a Committee be appointed to prepare a similar minute in regard to Dr. HOLLEY, the President named Prof. T. EGLESTON and Mr. ELLIOTT as such Committee.

Prof. A. R. LEEDS exhibited a fine specimen of Natrolite, from the new tunnel now in progress through the Bergen Hill.

Mr. G. F. KUNZ showed a remarkably large crystal of Arkansite, from Arkansas; and also a peculiar hydro-carbon mineral from near Milan, Lombardy, which bore considerable resemblance, in several respects, to the peculiar coal-like peat discussed by Prof. FAIRCHILD at the meeting of Dec. 19th.

Prof. J. S. NEWBERRY then presented the paper of the evening, entitled

THE ORIGIN AND RELATIONS OF THE CARBON MINERALS.

The following is a brief synopsis of the paper, which will appear in full in the Annals of the Academy:

(Abstract.)

1. The so-called "carbon minerals," peat, lignite, coal, anthracite, graphite, petroleum, etc., are not, properly speaking, minerals, as they are without definite chemical formulæ or crystalline forms. They are groups of organic substances, vegetable or animal, the products of progressive changes incident to their nature and reaching their inevitable end in complete oxidation.

2. The principal source from which these substances are derived is vegetable fibre, which consists of organic tissue with a variable quantity of inorganic matter woven into its composition, which remains after oxidation, and is called ash. The organic portion consists, in round numbers, of carbon fifty per cent, oxygen forty-two per cent, hydrogen six per cent, nitrogen two per cent. Like all organic matter, this has been formed under the influence of the vital force, in antagonism to the affinities of inorganic chemistry; and when abandoned by this creative and conservative force, it is necessarily, though more or less slowly, oxidized. When very rapid, this change is called combustion; when less rapid, decay; and when operating very slowly, it becomes a kind of distillation, in which the constituents react upon each other, forming definite or indefinite compounds that retain the solid state or assume liquid or gaseous conditions. In the progress of this change to complete oxidation, an equal amount of force is evolved with that absorbed in the growth of the organic structure. By controlling the exhibition of this force, we utilize it in the form of heat, light, motive power, etc.

3. The changes which take place in organic tissue result in the formation of two classes of products—*residual* and *evolved*. The residual products of the spontaneous distillation of wood-tissue are solids, which are grouped under the conventional and undefinable names of peat, lignite, bituminous coal, semi-bituminous coal, anthracite, graphitic anthracite, and graphite. The evolved products are carbonic acid, carbonic oxide, and numerous hydrocarbon and nitrogenous gases, and the liquids water and petroleums. From the latter, by a kind of spontaneous distillation, are derived non-oxidized solids, paraffine, ozokerite, etc., and oxidized solids, asphalts. From these last are derived asphaltic coals, Grahamite, Albertite, etc.

4. The residual products are portions of a continuous series, beginning with wood-tissue and ending with the ash or inorganic portion left when the organic matter is distilled away, each group showing

considerable diversity of composition, and graduating insensibly into those above and below.

5. The evolved products are given off in all stages of the progressive change. They, too, are usually mixtures when eliminated, and are constantly changing by the absorption of oxygen and conversion into their final state, carbonic acid.

6. The escape of the evolved products is constantly taking place from all great accumulations of carbonaceous matter; the gases commonly and the liquids occasionally are seen escaping from beds of coal; and both abundantly from the much greater accumulations of carbonaceous matter in bituminous shales, gas and oil springs being inseparably connected with the outcrops of all these great deposits. Coal and petroleum also spontaneously change when exposed to the air, the coal rapidly losing its volatile constituents, and with them its value for the manufacture of gas and coke; petroleums becoming by evaporation and oxidation thicker and darker, finally forming asphalt, or without oxidation, paraffine, ozokerite, etc.

7. The differences which we observe in the residual and evolved products are in part due to peculiarities in the organic tissue from which they are formed, and in greater degree to the stage of distillation that they have reached. Different kinds of vegetation, as oaks, pines, ferns, algæ, etc., having somewhat different compositions, yield diversified products in distillation; and petroleums, though mainly derived from cellular plants (seaweeds, etc.), are in part the products of the distillation of animal matter, and owe some of their characteristics to that fact.

8. Every step in the process described above is abundantly illustrated in our coal and oil fields, all of which have been studied by the speaker. The views presented are not the coinage of the imagination, but a simple transcript from nature; and they are sustained by such an array of facts as to compel their acceptance. Instances were given of the conversion of lignite into coal, anthracite and graphite, by volcanic action, and of the natural derivation of asphalt, asphaltic coals, and anthracite, from petroleums.

9. Further the great work going on in nature's laboratory may be closely imitated by art; the differences in the results being simply the consequence of differing conditions in the experiments. Vegetable tissue has been converted artificially into the equivalents of lignite, peat, anthracite and graphite, with the emission of vapors, gases and oils, closely resembling those evolved in natural processes. So petroleum may be distilled to form asphalt, and this in turn converted into Albertite and coke (*i. e.*, anthracite). Grahamite has been artificially produced from petroleum by Mr. W. P. Jenney.

10. The theories proposed by Berthelot, Daddow, Byasson, and Mendelejeff, for the genesis of petroleum, are the results of speculation in the study or irrelevant experiments in the laboratory, and have no confirmation or illustration in the facts of nature.

February 13, 1882.

SECTION OF PHYSICS.

The President, Dr. NEWBERRY, in the Chair.

Forty persons present.

Prof. ROBERT H. THURSTON read a paper,[1] entitled

ON THE BEHAVIOR OF STEAM IN THE STEAM-ENGINE CYLINDER, AND ON CURVES OF EFFICIENCY.

(Abstract.)

In an earlier paper[2] the writer had shown what are the conditions determining the ratio of expansion in steam engines working at maximum efficiency, and how those conditions vary in different types of engine, and also how essentially different is the actual working engine, in all that effects that ratio, from the hypothetical case usually taken, in which the steam is assumed to expand adiabatically in a non-conducting steam-cylinder. It was finally shown what were the best values of this ratio for several standard types and representative cases, as determined by the writer by direct observation and by the study of experimentally obtained results, the precise figures given being obtained by rules of simple form so deduced.

It was shown that first friction and then—often to a vastly greater extent—cylinder condensation, due to expansion of a heated fluid in a working cylinder made of a material of high conducting power, modify the methods of expansion and of expenditure of heat so greatly that the ratio of expansion for maximum efficiency, in unjacketed engines, rarely exceeds $\frac{1}{2}\sqrt{P}$, where P is the gauge pressure in pounds per square inch, although its value would otherwise be, often, several times greater. It was also shown that these modifying conditions very differently affect different kinds of steam engine, and different engines, and also individual engines, at various pressures and piston speeds.

In this paper it was proposed to show more fully what is the behavior of steam in the steam-engine cylinder and to exhibit the form taken by the expansion-line; to give values of mean pressures obtained under

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[1] Published in full in the Journal of the Franklin Institute, February, 1882.

[2] On the Ratio of Expansion at Maximum Efficiency in Steam Engines; Trans. Am. Soc. Mech. Engrs., 1881; Jour. Franklin Institute, May, 1881.

various conditions, and finally, to show the method devised by the author for laying down curves of efficiency, and to show what conclusions follow from their study.

It was shown that in no case, in steam engines as to-day constructed, can the expansion-line or the curve of mean pressures be such as would be obtained in a non-conducting cylinder. Steam must always be more or less condensed at the beginning and must always carry away heat by its re-evaporization at the end of the stroke. The steam-jacket checks the first operation, but accelerates the last, and, with wet steam, may scarcely decrease the evil that it is designed to prevent.

It was stated that the adiabatic curve may be closely represented by a regular curve of the hyperbolic class, $p_1 v_1^n = p v^n$, the exponent n varying with the proportions of steam and water in the mixture at the commencement of the expansion, which is assumed to take place in a non-conducting cylinder. Zeuner finds the value of n to be nearly $n = 1.035 + 0.1\ x$, x being the proportion of steam present.

Table I, appended to the paper, gave the values at the ratio of mean pressure to initial pressure $\frac{p_m}{p_1}$, for various mixtures from steam 1.00, water 0, to steam 0.50, water 0.50, assuming the formula to be practically accurate within that range.

With these are given the adiabatics for superheated steam, $n = 1.333$.

Table II gave the values of $\frac{p_m}{p_1}$ for steam-expansion in a jacketed metal cylinder, in which it is kept just dry and saturated by heat from the jacketed sides and ends; the values for wet air compressed in air-compressors, in which n is frequently found to be 1.2; and for peculiar cases in actual steam engines in which leakage or re-evaporation, or both, raise the terminal pressures greatly, giving $n = 0.50$, $n = 0.75$.

It is, as yet, impossible to predict which of these curves will be found in ordinary engines, and the engineer is compelled to rely entirely upon the "indicator" for information of this character; this instrument gives him a more or less exact graphical representation of the changes of pressures and volume throughout the stroke. The greatest possible variety of curves are found to occur in such cases, but they approach the adiabatic more nearly, as the steam is drier and, as the speed of piston is increased, rarely departing far from the common hyperbola in good engines.

The values of $\frac{p_m}{p_1}$ given in the tables are plotted on Plates I and II, and from these a better idea can be obtained of the method of variation of mean pressure and of work done with variation of the ratio of

expansion, and a better notion of the relation of these several curves gained, than by the study of the tabled quantities.

The writer next describes the curves of efficiency, of work and of mean pressures, to be obtained where steam is expanded in a non-conducting cylinder. They are easily deduced and easily constructed, and, by reference to Zeuner's formula, the engineer can determine them with a satisfactory degree of accuracy for all cases likely to arise in his practice.

Next, studying the behavior of steam in a metallic cylinder, he finds vitally different conditions and results; but given the law of variation of composition of the mixture with change of point of cut-off, or of ratio of expansion, it is, nevertheless, not only practicable but easy to determine curves of efficiency and to deduce values of the best ratio of expansion for any given case.

Where direct experience can be resorted to, to determine the cylinder condensation, it is easy, as shown later, to obtain *exact* results when seeking the ratio of expansion at maximum efficiency of fluid, of engine, or of capital, or in the solution of a rarer case which requires that the point of cut-off which gives most work for a given expenditure on the whole plant be determined.

The author describes and illustrates the construction and application of curves of efficiency for real engines, in the solution of important problems, and concludes by summarizing his work and leading the reader to the final deductions:

"The curve of variation of efficiency above traced, of which the abscissas measure varying quantities of steam used in a given steam-cylinder, while the ordinates are proportional to the quantities of work done by those amounts of steam, is a curve of entirely different character and form, and often widely different in location, from the curve of adiabatic mean pressures or other curve of mean pressures exhibiting the work done by various quantities of steam expanding under given fixed conditions in a non-conducting vessel.

"That no predetermination of the efficiency of any proposed engine, whether of fluid, of machine, or of capital, can be made unless the true curve of efficiency can be obtained for the assumed case.

"That the most certain and the most satisfactory solution of any problem of efficiency will be that obtained by first securing the elements of the curve of efficiency from actual engines operated in the manner proposed for the case taken.

"That having obtained by experiment upon any engine, the 'curve of efficiency,' as defined by the writer, the efficiency of fluid, of engine, and of capital expended to do a given amount of work, and the quantity of work to be obtained most cheaply from a given engine, may all

be obtained for any given set of conditions, and the ratio of expansion at maximum efficiency, of fluid, of engine and of capital, and the ratio of expansion which, with a given plant, gives most work for a dollar of expense of operation, may all be determined with a degree of exactness only limited by the magnitude of the errors of observation.

"That the necessity of following the direction of improvement pointed out and entered upon a century ago, by Smeaton—the protection of the working fluid from losses of heat, by surrounding it with non-conducting surfaces—constitutes the most imperative of all demands to-day upon the mechanical engineer engaged in designing steam engines."

Prof. W. P. TROWBRIDGE made some remarks on the paper of Prof. THURSTON, expressing his high appreciation and interest, and treating of the importance of the subject.

Professor CHARLES F. HIMES, of Carlisle, Pa., presented the following paper, which in his absence was read at his request by Mr. W. LE CONTE STEVENS:

STEREOSCOPIC NOTES.

The interesting and exhaustive papers lately written by Mr. W. LE CONTE STEVENS have recalled corroborative experiments in a similar direction, made by myself about 1860, while critically examining the brochure[1] published by Sir DAVID BREWSTER, which did so much in connection with the lenticular stereoscope devised by him, and the rapid multiplication of photographic slides for it, to popularize the beautiful discovery of Wheatstone. By experiments with large photographs, specially prepared, without instrumental assistance, I found, as Mr. Stevens has in his experience, that convergence of the optic axes to a positive point was altogether unnecessary for the production of stereoscopic effect, as published in 1862 and subsequently,[2] and therefore that the binocular criterion of distances, as so clearly enunciated by Bishop BERKELEY in his *Theory of Vision*, must consist in movement of the optic axes successively converged on different points of an object, rather than in the degree of convergence of the axes.

At the same time, while experimenting upon the application of the stereoscopic principle to the solution of some scientific and metaphysical problems, I was led to discard the rather complicated and unsatisfactory diagram suggested by Sir DAVID BREWSTER for the explanation of the *Phenomenon of the Horizontal Moon*,[3] as well as the somewhat better one suggested by Professor RUETE,[4] and to

1 The Stereoscope, London, 1856.

2 Am. Jour. Phot., Sept. 1, 1862; Journal of the Franklin Institute, Phila., Vol. XCII. (1871), Nos. 549, 550, 551; Vol. XCIII., Nos. 553, 556, 556, 558.

3 The Stereoscope, p. 201.

4 Das Stereoscop, Leipzig, 1860, p. 86.

substitute one more in accordance with the theory of rapid successive convergency of the optic axes in the estimation of distance. The effect was a decided surprise in its illustration of the phenomenon, but even more so as a corroboration of the theory. It consisted simply of two concentric circles, respectively 1⅝ inch and ⅞ inch in diameter as the left-eye picture, and a circle 1⅝ inch in diameter, enclosing two circles ⅞ inch in diameter each, with their centres respectively 1-10 inch to the right and left of the centre of the large circle, as the right-eye picture, the centres of the large circles being about 2⅝ inches apart. The expectation was, that the successive combination, so to speak, of the small circles of the right-hand figure, could at least be made so rapidly that a comparison of the sizes could be made at the varying apparent distances. The apparent *simultaneousness* of the appearance of the near and remote circles, with the expected difference in apparent size, constituted the surprise, which has been experienced by every one upon examining such a slide for the first time. Attention was called to the diagram in a published discussion of some of Sir DAVID BREWSTER'S views of the theory of the stereoscope in 1864, in the *British Journal of Photography;* and subsequently a dealer in stereographs placed it among his slides; but it is more than possible that even those interested in this subject may not have met with it, and I have therefore presumed to call attention to it in connection with the very interesting articles upon the subject before alluded to.

CARLISLE, Pa., January 30, 1882.

Mr. STEVENS exhibited the stereograph described by Professor Himes, and by large diagrams on paper explained the difference between this and Brewster's method of illustrating the phenomena of the horizontal moon. In addition, he remarked substantially as follows:

"It gives me much pleasure to present this paper by Professor HIMES, and to call attention to his careful observations on the nature of binocular vision, which were made twenty years ago, and have not received the full notice to which they were properly entitled. The great name of Sir DAVID BREWSTER carried with it a degree of authority which caused the general acceptance of the geometric theory of binocular vision. Professor W. B. ROGERS,[1] in this country, had also written a series of very able papers, in which he calculated what must be the form of the externally projected binocular image, assuming each point of this to be determined by intersection of visual lines. Professor HIMES discovered that such intersection is not necessary; but, unfortunately, his paper on this subject was not published in the *American*

1. Am. Jour. Science, vols. XX. and XXI., 1855 and 1856.

Journal of Science. (Mr. STEVENS here read an extract from the original paper, published by Professor HIMES, in the *American Journal of Photography* for September 1, 1862.) Shortly before the appearance of this paper, two Germans, ROLLET and BECKER,[2] published a method of securing binocular fusion of similar images with optic divergence, the possibility of such fusion having been already mentioned by BURCKHARDT. Professor HIMES' experiments were doubtless contemporaneous with those of the Germans just named, and were wholly independent of them.

"My own discovery of the possibility of stereoscopic vision by optic divergence was likewise independent. I subsequently learned of the previous experiments on this subject by ROLLET, BECKER, and HELMHOLTZ, and duly credited them in my paper before this Academy on the 6th of last June. Professor HIMES' papers were sent me after mine had been published in the *American Journal of Science* for last November. He deserves the credit of being the first in the country to secure stereoscopic vision with conscious optic divergence. My own claim is based rather upon the analysis than the discovery of this mode of stereoscopy. For years past, oculists have subjected their patients to the use of prisms for the purpose of testing the strength of the external rectus muscles of the eyeballs, in diverging the visual lines while the eyes receive, from an object in front, rays of light that are refracted by transmission through the glasses. In view of this fact, it is remarkable that BREWSTER'S geometric theory of stereoscopic vision should still hold its place in our text-books of physics. His theory of color has been abandoned, and his theory of binocular perspective is awaiting the same fate.

"In regard to the phenomenon of the apparent enlargement of the moon when seen at the horizon, Professor HIMES' stereograph gives an excellent illustration, superior to that of BREWSTER,[3] because the two parts, which are to be contrasted in the external projection of the binocular image, are more nearly aligned, and no motion of the stereograph is necessary. While the angular diameter of the moon remains nearly constant, being slightly greater when near the zenith, because the observer's true distance is diminished by nearly the earth's semi-diameter, its apparent magnitude varies with its estimated distance, and it appears much smaller when near the zenith, instead of larger. The cause of this illusion of distance, producing an illusion in regard to size, which is well illustrated by the present stereograph, has been the subject of much discussion. In so late a book as LOCKYER'S *Astronomy*,[4]

2. Helmholtz, Optique Physiologique, pp. 827, 828.
3. The Stereoscope. London, 1856, p. 201 *et seq.*
. Elements of Astronomy, Appleton & Co., N. Y., 1873, p. 116.

(1873), it is attributed to unconscious comparison with terrestrial objects at the horizon. If such be sufficient, there should be no apparent enlargement when the rising moon is seen upon a calm ocean ; but this is the condition under which the phenomenon is really most striking. For the following brief sketch of the views that have been held, I am indebted mainly to HELMHOLTZ.[5]

The first opinions put forth on the perception of the third dimension in space were in connection with these differences of apparent size of the moon.

PTOLEMY (A. D. 150) said that the mind judges of the size of objects in accordance with the previous appreciation of their distance ; this would appear greater when there are many intervening objects, since this occurs when the heavenly bodies are near the horizon. Nevertheless, he elsewhere attributes the enlargement to the refraction of rays by vapors.

ALHAZEN (1038) refutes the latter opinion and returns to the first. He is followed by ROGER BACON, and opposed by BAPTISTA PORTA.

VITELLION (1271) accords with ALHAZEN, and observes additionally that the whole celestial vault appears more elongated horizontally than toward the zenith.

KEPPLER (1604), whose opinion was adopted by DESCARTES, said that the distance between the two eyes is the base which we employ in measuring the distance of objects. We have here the first enunciation of the binocular theory afterward so emphasized by BREWSTER. KEPPLER adds that since, in making measurements with the two eyes, we learn to make them with the single eye, the magnitude of the heavenly body, as perceived in the eye, would serve as a base for distances relatively slight. We furthermore appreciate different degrees of light, and practically compare the size of an object with its distance, since we know by experience how much to extend the hands or to advance toward an object to touch it. KEPPLER thus knew the most important elements of the appreciation of distance, aside from that of dissimilarity of images.

The subject has been further considered by GASSENDI (1658), HOBBES (d. 1679), MOLYNEUX (1687), DE LA HIRE (1694), PERE GOUYE (1700), BERKELEY (1709), R. SMITH (1728), LOGAN (1736), DESAGULIERS (1736), BOUGUER (1755), PORTERFIELD (1759), SAMUEL DUNN (1762), MALEBRANCHE (1764), LAMBERT (1765) and EULER (1768).

The opinions expressed by these writers need not be repeated, except to say that BERKELEY insisted upon the dim and pale aspect of

5. Optique Physiologique, p. 870 *et seq.*

the moon at the horizon, attributing the judgment of increased distance to aerial perspective, as it is viewed through a thicker bed of air. This is unquestionably one of the most important elements, but BREWSTER[6] specially denies its value in the present case. Dr. R. SMITH made a series of estimates, sometimes toward the horizon, sometimes toward the zenith, and found that the distance of the horizon appeared from three to four times greater than that of the zenith.

HELMHOLTZ[7] gives reasons why the celestial vault should appear flattened, even though there is no such limiting surface to the space overhead. The path of the visible moon is referred to this imagined semi-ellipse; and to this circumstance, combined with aerial perspective, is mainly to be referred the illusive judgment of variation in its distance.

This illusion is by no means confined to our estimation of the distance of heavenly bodies. Most persons have probably observed the apparent magnification in distance of the ground when viewed from a lofty window compared with that of the window when viewed from the ground. In this case aerial perspective can scarcely be considered, and there is nothing to produce the illusion of a geometrically regular surface below. It seems highly probable that physiological rather than mathematical conditions are operative in producing the illusion."

Mr. W. LE CONTE STEVENS exhibited

A NEW REVERSIBLE STEREOSCOPE.

The objects to be attained in constructing this stereoscope were —

I. To secure ready motion to the semi-lenses, so that they may be adapted in position for any pair of eyes, whatever may be the interocular distance, and for any stereograph, whatever may be the stereographic interval within the usual limits.

II. To secure ready motion to the screen, so that the whole stereograph, or either separate half of it, may be visible to each eye, at will.

III. To secure the possibility of removing the semi-lenses, so that they may be reversed in relative positions, or be substituted by prisms with their bases toward each other, so that the left and right pictures may be simultaneously viewed, without discomfort, by the right and left eyes respectively, thus securing reversion of relief in the binocular image, if desired.

IV. To secure the means of examining the binocular image either alone or attended by monocular images, so that the difference between the two kinds of vision may be noted.

V. To secure the means of using the same instrument, either with

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6. The Stereoscope. London, 1856, p. 201 *et seq.*

7. Optique Physiologique, p. 800 *et seq.*

glasses or for binocular combination of images by direct vision, and to reduce the difficulty usually attendant upon stereoscopic vision by the latter method.

VI. To secure the means of producing stereoscopy from perfectly similar pictures by making the retinal images of these dissimilar.

The construction and manipulation of the instrument was illustrated in full; but a description of this is not given in the present abstract, because already furnished to the *American Journal of Science.* A printed description also accompanies each instrument, as issued by the manufacturers, Messrs. E. & H. T. ANTHONY & CO., 591 Broadway.

The feature in binocular vision, mentioned in paragraph VI. above, has not been explained hitherto, and has been but rarely perceived. If an object possessing three dimensions in space be held within a short distance and viewed alternately by the right and left eyes, the retinal images of it at these different standpoints are necessarily dissimilar. On this principle depends the whole art of stereoscopy, as illustrated with the instruments and stereographs in ordinary use. Each of the latter consists of two pictures of an object, taken from different points, so as to secure dissimilarity. The binocular combination of their retinal images hence presents the appearance of solidity, independently of any perspective effect secured by art.

If a large plane surface, on which are drawn similar figures regularly recurring at equal distances apart, be appropriately viewed with very strong cross vision, so that a phantom image, reduced in size, is seen in mid-air, the latter appears slightly curved, with the convexity toward the observer. This mere fact was first noticed by Sir DAVID BREWSTER, but on his theory of visual triangulation, the phantom image should be a plane, parallel to the given plane. The appearance of any convexity would disprove his theory, and BREWSTER undertook no explanation of what was to him, under the circumstances, probably not a striking phenomenon. This long-forgotten peculiarity of the phantom image, or at least its curvature in one direction, has lately been rediscovered by Professor LE CONTE, and its curvature in all directions by myself. It was at first regarded as one of the consequences of strong convergence of visual lines. By using, instead of a large plane surface, a card on which the two pictures are perfectly similar, such as a pair of series of concentric circles, and cutting the two halves apart, the horizontal visual lines may be made parallel while the two small cards are oppositely inclined to them, at any desired angle, by rotation about a pair of vertical axes. Each plane may thus bear to the visual line that meets it the same relation that would result from strong convergence or divergence in viewing a single continuous plane. The binocular effect is that the combined surface appears convex or concave, at will, by varying the

angle formed by the planes of the cards on which the pictures have been have made.

Mr. STEVENS proceeded to explain and illustrate these effects in a series of diagrams, showing how this curious and novel result is due to the fact that, through the crystalline lenses, the images of the similar drawings, obliquely viewed from opposite sides of the normal to each picture, are projected upon retinal surfaces which are not planes, but nearly spherical, and hence are slightly dissimilar.

The full description of the reversible stereoscope, and the geometric discussion of the new method of stereoscopy, may be found in the *American Journal of Science* for March and April, 1882, the *London Philosophical Magazine* for April and May, 1882, and the *Popular Science Monthly* for May and June, 1882, in which latter it will appear as an illustrated article.

Feb. 20, 1882.

LECTURE EVENING.

The President, Dr. NEWBERRY, in the Chair.

The hall was completely filled.

Mr. WM. E. HIDDEN exhibited an extraordinarily large crystal of Monazite, from North Carolina.

The second lecture of the regular monthly course was then delivered, by Dr. J. S. NEWBERRY, upon

THE ANCIENT CIVILIZATIONS OF AMERICA.

(Abstract.)

Two distinct civilizations have left their traces in different parts of North and South America: 1. That of the Mound-Builders in the Mississippi Valley; 2. That of the Stone House or Temple-Builders of the table-lands of North America, the Isthmus, and the western coast of South America.

Of these the relationship is obscure, and no certain proof has been furnished of their synchronism or their genetic connection.

(I.) The whites, on their advent, found the east coast of North America covered with dense forests, and inhabited by wild animals and the nomadic Indians. It was only when the wave of migration had reached the basin of the lakes and the valley of the Ohio, and the forest was then cut off, that mounds, earthworks, mines, etc., were brought to light, which prove that this region had for ages been occupied by a numerous, sedentary, and partially civilized people. The date of their occupation of the Mississippi Valley cannot be accurately determined. Their works had been abandoned and overgrown by the

forest at least a thousand years—as shown by two generations, living and dead, of mature forest trees which covered them.

These ancient people were agricultural in pursuits, built towns of considerable size, and left such abundant traces as to prove that the population of the region they occupied was as great as the present one.

The degree of advancement in the arts which the relics of the Mound-Builders exhibit is such as to raise them above the condition of absolute savagery, but they were hardly civilized in the present acceptation of the term. Their works were varied in character, and frequently of imposing dimensions, and consisted of fortifications, sepulchral mounds, and extensive structures designed apparently for ceremonial and religious purposes. These are all of earth or rough stone, and there is no evidence of any progress in the mason's art. The buildings were probably of wood, the foundations alone remaining. These people worked the copper-mines of Lake Superior, the oil-wells of Pennsylvania, Ohio and Michigan, the lead-veins of Kentucky, and the mica-mines and steatite-quarries of the Alleghany range; but all this mining in the rock was done by means of stone and wooden implements, and the use of fire; they left no evidence of the possession of other metals than copper, and this was used only in its native state, was never melted, and was fashioned by hammering. They had woven fabrics made with considerable skill from the fibres of plants. Their pottery was generally coarse in material and rude in form, but in some instances was graceful in shape, made of finer clay, and ornamented with incised or painted designs. Their burial ceremonies were apparently elaborate, and cremation was often practiced. Their bones have generally been found decomposed by age; but from such as have been preserved, we may infer that in proportions and form of cranium this race resembled the average Indian, and that they belonged to the great American family of man.

We have as yet no evidence of their possessing domestic animals, and no accurate information in regard to their crops, except that maize was their great staple.

The wide distribution of marine shells throughout the interior of the continent—used for implements or ornaments, of beads, and of mica and copper, soapstone and flint, all from known localities shows that there was considerable internal commerce, but no positive evidence exists of interchanges with foreign nations. The discovery in the mounds of tablets, engraved with symbols or ornaments of a Mexican type, indicates communication with the civilized occupants of the table-lands; but the rarity of these relics and the absence of monuments from a broad space separating their countries, leads to the inference that their intercourse was limited and their relationship not close.

The fate of the Mound-Builders was for the most part extermination by incursions of the more warlike northern nomadic Indians, who had occupied the whole country at the advent of the whites; but it is probable that in the Mandans and Natchez some remnant of the Mound-Builders continued to exist after the occupation of America by Europeans.

(II.) The table-lands of North America, from Salt Lake to the Isthmus, are thickly set with the remains of a civilization much more advanced than that of the Mound-Builders. These are the works of a people at one time far more numerous than at present, though still represented by scattered colonies in our southwestern territories, and found in the occupation of Mexico by Cortez. They were characteristically workers in stone, and have everywhere left monuments of their skill in constructive masonry, which inspire respect and often admiration. The structures raised by this people are mostly communal houses and compactly built towns, but they are often citadels and watch-towers. Many of these are erected with special reference to defence—their exterior walls being unbroken to the height of 15 or 20 feet, and the interior accessible only by ladders. In many instances the towns and houses are located on high and almost inaccessible rocks, evidently with a view to defence. A few of the towns within our own territory, peculiarly well defended by their natural positions, continue to be occupied to the present day—such as the Moqui villages, Acoma, Zuñi, etc.—but most of the area where once a dense population existed has been entirely abandoned. Every available inch of arable land seems to have been cultivated by them, hill-sides terraced, and water for irrigation and drinking brought many miles in canals, and stored in well-built stone cisterns. In the northern provinces of the country inhabited by this people metals seem to have been unknown, and all wood and stonework was accomplished with stone implements.

The modern representatives of these ancient people are peaceful, industrious, ingenious, temperate and moral; they cultivate the soil with great care, and are well clad in softly dressed skins of sheep and deer, or in woolen garments woven by hand, but often very tastefully ornamented and serviceable. They excelled in the manufacture of pottery, which is often graceful in form, and elaborately ornamented with colored designs.

The metropolitan population of Mexico was, however, further advanced in the arts, having well-built and paved towns, good roads, with relay stations for couriers, parks, fountains, courts of justice and police. They also had a written language and picture writing, both on paper, with elementary and professional schools. They employed a

number of the metals, gold and silver as ornaments, tin and copper combined to form bronze, which was used for arms and utensils. The structures which they erected were frequently composed of stones of large size, carefully dressed and laid in mortar, with the interiors plastered and painted. The external architectural decoration was frequently exceedingly elaborate and often very tasteful. Their religion was apparently sun-worship, and they frequently offered human sacrifices.

The monuments of Central America and Peru show such resemblance to those of Mexico, that we cannot doubt that the people occupying all these countries must have been in close communication, and intimately related. The monuments of Central America have been described and illustrated by Stevens and Catherwood, Waldeck, Norman, etc., and their number, magnitude and ornamentation have excited great interest and admiration ; but it is believed that only a small portion of these monuments has yet been examined, and that in the dense forests of Honduras and Yucatan there yet remain a large number of towns and individual structures to reward the efforts of future explorers.

In Peru, as in Central America, the population in possession of these countries at the time of the Spanish conquest was the same that had erected the monuments ; but in both, as in Mexico, the iron hand of despotism and religious bigotry has nearly exterminated the population, and has destroyed their records, until their characteristics and history are scarcely better known than those of the Egyptians and Assyrians.

The monuments of the Incas and their predecessors in South America are briefly described by the Spanish historians, and have lately been studied by one of our number, Mr. E. G. SQUIER ; and their magnitude and interest may be inferred from his statements that the masonry of some of the Peruvian buildings excels anything he has elsewhere seen ; that the great Incarial roads extending from Quito to the frontiers of Chili were constructed with more labor and engineering skill than our Pacific Railroad, and that one fortress guarding a pass in the Andes contains more masonry than all of our coast defences from Maine to Florida. Although exhibiting local differences, the similarities in the remains of the ancient inhabitants of Mexico, Central America and Peru, are such that we are compelled to believe that their civilization was generically the same, and that all these peoples were offshoots from a common stock. The monuments in Central America are often covered with inscriptions, while these are almost wanting in Mexico and Peru ; but both these peoples used paper for writing, and were as little in the habit of making inscriptions on stone as we are, or as most civilized nations of Europe. Therefore the absence of inscriptions cannot be accepted as evidence of inferior enlightenment.

Everything indicates that the civilization of Central America, Mexico and Peru was indigenous, and sprang from a common source, spreading along on the west slope of the Cordilleras from Chili to Central America, and northward to the fortieth parallel. Throughout this region the phases of development were essentially alike, and it is probable that constant intercourse was maintained by sea between South and North America.

The origin of this peculiar civilization is a problem not yet solved, but it is almost certain that it borrowed nothing from Europe, Africa or Asia.

Some facts seem to indicate that it was a growth from seed imported from India by way of the Pacific Islands, many of which contain stone monuments and structures which have a striking resemblance to those of the west coast of America.

Dr. NEWBERRY spoke somewhat fully of his own observations and experiences among the Zuñi villages, at a time when scarcely any Americans had ever before visited them; and also of the peculiar remains of ancient mining operations in the Lake Superior copper-region and in certain of the oil-wells of Pennsylvania and Ohio, as studied by himself. At the close of the lecture he showed a number of very finely-wrought pieces of ornamental weaving obtained among the Pueblo tribes, and a large series of lantern views illustrating the several topics treated of in the course of the lecture.

February 27, 1882.

ANNUAL MEETING.

The President, Dr. NEWBERRY, in the Chair.

Thirty-eight persons present.

The report of the Treasurer, Dr. JOHN H. HINTON, was read.

The principal receipts during the year had been: from initiation fees and annual dues, $1,535.00; from interest on bonds, $152.00; from subscriptions to and sales of the Annals, $335.86; and from contributions to the Patrons' Fund, $100 each from Professor A. R. LEEDS and Mrs. HENRY HERMANN. The chief items of expense had been: $500 for binding portions of the library, and $689.68 for printing and engraving (Annals, circulars, notices of meetings, etc.); for rent of the society's rooms there had been paid, $469.50; and for three U. S. 4 per-cent bonds (to Patrons' Fund), $354.37.

The report of the Recording Secretary, Dr. O. P. HUBBARD, was presented.

Thirty-four sessions of the Academy and eight meetings of the

Council had been held during the year. The papers and communications presented at the meetings had been very varied and valuable. Besides five public lectures, fifty-five formal communications had been made before the Society, which might be classified generally as follows: Archæology, 2; Biology, 3; Chemistry, 4; Geology, 18; Mineralogy, 17; Physics, 11. The average attendance at twenty-four meetings had been forty.

There had been added to the resident membership during the year, twenty-six persons; fourteen had resigned, and two had died—JOHN W. DRAPER, M. D., LL. D., and ALEXANDER L. HOLLEY, E. M.

The Secretary suggested the propriety of further efforts to enlarge the membership of the Academy.

In the absence of the Librarian (Dr. ELSBERG) the President addressed the meeting in reference to the library, reporting the great amount of work that has been done during the past two years, in arranging, cataloguing, and binding the books and pamphlets. The heavy expenses involved in this most necessary and important work have severely taxed the Academy's finances; but as the work is now substantially done, and the chief expenses over, the Society is to be most heartily congratulated in the matter. The great and valuable library is now, for the first time in many years, brought into a satisfactory condition; and having permanent quarters in a positively fireproof building, its security and utility are assured.

Prof. THOMAS EGLESTON reported further in the same strain, in behalf of the Library Committee. He presented to the Society the question of employing a paid librarian, which was referred to the Council; and announced that the arrangements were so far completed in reference to the binding and arranging of the books, that the library would be formally opened for use by June.

The Corresponding Secretary, Dr. A. R. LEEDS, presented his report, relative to the correspondence of the Academy during the year.

Prof. D. S. MARTIN presented the report of the Committee on Publications. The "Annals" of the Academy had been carried on as usual—Nos. 5 and 6, of Volume II, having been issued before the summer adjournment of the Society; and Nos 7 and 8, which had been unavoidably delayed, being nearly through the press, and very soon to appear. Besides this, a large amount of labor had been expended during the summer and fall of 1881, in the preparation and issue of the Index to Volume I.

The publication of a journal of the Academy's meetings, with the briefer papers and discussions, which had been so long desired and aimed at, had finally been undertaken in the printing of the TRANS-

ACTIONS. This had been accomplished largely by the care and pains taken by Dr. A. A. JULIEN, who had concluded arrangements with the weekly journal, "Science," to publish regular reports of the Academy's proceedings, after which the type could be re-arranged so as to issue the record in a pamphlet form for free distribution to the members. Mr. MICHELS, the editor of "Science," had been very accommodating in the whole matter; and the result was that the TRANSACTIONS could thus be issued at a very moderate cost to the Society. This publication had now been undertaken as an experiment, for one year; and it is hoped that the movement would be so sustained as to assure its permanence.

A change was recommended in the price of the "Annals," from $2 (which rate would be continued to resident members) to $3 for non-residents, and $5 for persons living in the city and not members of the Academy. The TRANSACTIONS are to be sent free of cost to resident members, and furnished to others at the same prices as those just mentioned for the "Annals."

Prof. T. EGLESTON addressed the Society with reference to the approaching Convention to be held at Washington, in regard to the question of organizing the system of International Time, and selecting standard meridians. He recommended that the Academy should take action similar to that of some other scientific bodies, in appointing a delegate to that Convention.

Prof. JOHN K. REES was nominated as such a representative of the Academy, and unanimously elected.

The Society then proceeded to the annual election of officers, with the following result—all being chosen unanimously, save a very few scattering votes:

President,

JOHN S. NEWBERRY.

First Vice-President,
BENJAMIN N. MARTIN.

Second Vice-President,
ALEXIS A. JULIEN.

Recording Secretary,
OLIVER P. HUBBARD.

Corresponding Secretary,
ALBERT R. LEEDS.

Treasurer,
JOHN H. HINTON.

Librarian,
LOUIS ELSBERG.

Council,

DANIEL S. MARTIN,
THOS. EGLESTON,
ALFRED C. POST,
GEORGE N. LAWRENCE,
W. P. TROWBRIDGE,
LOUIS ELSBERG.

Curators,

BERNARD G. AMEND, B. B. CHAMBERLIN,
CHARLES F. COX, HERMAN L. FAIRCHILD,
WM. H. LEGGETT.

Finance Committee,

T. B. CODDINGTON, PHILIP SCHUYLER,
THOMAS BLAND.

THE PRESIDENT elect addressed the meeting, with a brief review of the work and progress of the Academy during several years past, its growth in numbers and in means, the increasing activity of its meetings, and the various grounds for encouragement and congratulation, albeit in the face of many obstacles, and the duty and responsibility of the members, and of all lovers of science and intellectual culture in the community, to sustain and further the interests and aims of the Academy.

Prof. A. R. LEEDS presented the following communication:

DIPHENYLAMINE–ACROLEIN.

Twenty-five grms. of diphenylamine in alcoholic solution were treated with acrolein in excess, and, after standing, the loosely-corked flask was gently warmed for a number of hours, until the smell of acrolein had nearly disappeared. A bulky, dark red precipitate was formed. On boiling with alcohol a deep red solution was obtained, and the portion undissolved formed a tenacious, sticky mass, very awkward to work with. By repeated boiling with water under a return cooler, this mass gradually lost its sticky nature. It was then digested alternately with boiling water and alcohol, until at last the mass became pulverulent, and could be ground up in a mortar. The operation of boiling was then repeated many times, the mass being powdered after each treatment with water, until at length the substance in a state of purity was obtained. Its analysis showed it to be diphenylamine-acrolein, or, as it might be termed, diphenylamine-allylene.

	Found.	Theory.
Carbon	86.26	86.18
Hydrogen	6.29	6.36
Nitrogen	7.28	7.45

It does not melt or sublime, but is decomposed on heating, leaving behind a carbonaceous residue extremely difficult of combustion. It is very slightly soluble in alcohol, insoluble in ether, and readily soluble in chloroform to a dark red liquid. From this solution, and also from that in glacial acid, in which it dissolves to a red liquid, but less readily than in chloroform, it could not be made to crystallize.

Its solution in chloroform was attacked with great energy by bromine. So also its solution in acetic acid, a dark red compound being formed on the addition of two atoms of bromine to one molecule of the diphenylamine. This compound was readily soluble in chloroform, but as it did not separate in a crystalline condition, its analysis was not made. It was probably the addition-compound $(C_{12}\ H_{10}\ N)_2\ C_3\ H_4\ Br_2$.

Its solution in acetic acid was attacked by nitric acid, forming a precipitate with a supernatant yellow liquid. Neither the solution nor the precipitate yielded a crystallizable nitro-product, and their study was abandoned.

March 6, 1882.

REGULAR BUSINESS MEETING.

The President, Dr. J. S. NEWBERRY, in the Chair.

Thirty-five persons present.

The report of the Council was read, recommending for election, as Resident Members, the following named persons, previously nominated in due form:

FREDERICK W. DEVOE, WILLIAM E. GAVIT,
E. AUSTIN OOTHOUT, DAVID ROUSSEAU,
FERD. J. G. WIECHMANN.

They were all elected by unanimous consent.

The PRESIDENT showed a specimen, brought by Miss F. R. M. HITCHCOCK, of the peculiar blue-paper-like corn bread, used by the Zuñi people, and referred to in his lecture of February 20th.

Mr. GEORGE F. KUNZ exhibited a unique specimen of asteriated blue sapphire, from Ceylon, from the cabinet of the late Mr. MACMARTIN of this city. The specimen is a perfect hexagonal pyramid, about two inches long, and an inch wide across the base, which latter is polished and displays a very beautiful asterism The color is a fine blue, though not transparent. Also a pink-tinted apophyllite, from the new tunnel through the Bergen Hill.

Mr. NELSON H. DARTON then read the following paper:

NOTES ON THE WEEHAWKEN TUNNEL.

(Abstract.)

The railroad tunnel now being cut through the trap of Bergen Hill, near Weehawken, has excited considerable attention among the mineralogists and others in this vicinity, on account of the following minerals:

Calc Spar. This in its first form is very abundant, in quite pure and perfect crystals, often with a fine yellow tinge, but seldom transparent: the variety known as dog-tooth spar has been found in excellent condition, but only in limited quantity.

It seems peculiar to this mineral here to occur in vertical veins in the trap, while most of the other species occur in beds more or less horizontal: thus showing most of the calcite here to have crystallized from inflowing water, filling up the fissures produced by various causes. Very little of it was found in cavities in the trap, as this does not seem to be amygdaloidal here. A few almost perfect geodes and druses of so called nailhead spar have been observed, mixed with the dog-tooth spar.

Datholite has been found mostly as druses or small crystals, which were very plentiful, sometimes as large crystals, weighing from three to six grains, and in good-sized groups. I noticed that the larger the crystals were, the more vitreous their lustre and the less their transparency. They generally occur in vertical veins, at right angles to those of the calcite ; when they occur in geodes, they are generally in cavities in the trap. This place is a new locality for *Hayesine*, which has, so far as I know, never been observed in any other place than in South America, and there mixed with gypsum and alum. About half a grain was secured here by scraping the cavity. On chemical examination it was found to be a borate of lime, containing but a mere trace of silica (derived probably from the scrapings of the cavity), *i. e.* Hayesine. The analysis used up nearly all obtained of this interesting mineral, and I am now eagerly seeking for more to verify my results.

Thomsonite has been reported at Bergen Hill, but I have never observed it.

Pectolite. Most of this species found here is a stellated variety, in which the fibers diverge at a greater angle than 45°. The fibers are rarely over two inches long. Masses weighing as high as three and even four pounds have been frequently found, and more or less is taken out every day, sometimes in beautifully perfect specimens,

Analcite. A few specimens have been obtained in fair sized crystals, occurring with dog-tooth spar ; but it is far from being abundant.

Apophyllite has been quite abundant, generally in white crystals, more or less perfect—occasionally pink. In one case, a pocket was met with, containing, besides some white and pink apophyllite, a little of a pure purple tint. It seldom occurs alone, but usually with calcite, datholite and stellar pectolite.

Prehnite is quite abundant in traces, never in large crystals, contrary to the conditions in the Pennsylvania railroad cut. It generally occurs in small cavities, and sometimes with calcite in some of the veins.

Sphene is met with in very small quantities, disseminated through the harder trap.

Stilbite. But little stilbite has been found, and that descending from some fissures into the natrolite.

Natrolite. This has been remarkably abundant. It has been found in groups of every shape, and in various sized crystals, sometimes in nearly perfect globes fully two inches in diameter, with druses, geodes, and other forms of great beauty and perfection. Most of it has been taken out in plates four or five inches square, and about five-eighths inch thick, coming from a bed spread over a large distance.

This has an average thickness of one-half inch, and is thrice intercepted by two inch veins of calc spar, running vertically.

Heulandite. Small crystals of this species are said to have been found in some cavities.

Laumontite. Some small weathered specimens of this were found in the trap, and it was also noticed quite plentifully in traces.

Chabazite has been quite rare, a few poorly formed crystals having been found on some of the masses of apophyllite; also two excellent crystals of a pure yellow tinge, and quite transparent.

Pyrite. This species is very abundant, profusely scattered through the trap, mostly in masses, but often in excellent crystals drused on the trap.

Chlorite (?) is quite abundant, in masses and large imitation crystals, weighing five or six pounds; most of it occurs in a vein about six feet wide, within a few feet east of the pyrite locality. It is of a very dark color, quite impure and brittle, and was mistaken for coal by some parties visiting this shaft, who spread the report that a bed of coal eight feet wide had been discovered.

In closing, Mr. DARTON expressed his belief that much more fine material would still be found in excavating the space between shafts numbers one and two.

The paper was illustrated with sections of the tunnel, and by many choice specimens of the minerals described.

DISCUSSION.

Mr. CHAMBERLIN, Mr. G. F. KUNZ, and Prof. D. S. MARTIN, made remarks on the paper, expressing much interest in the variety and beauty of the minerals found in this tunnel, and making comparisons with the modes of occurrence of like species in the other Bergen tunnels.

Mr. WM. EARL HIDDEN, then read the following paper:—

A PHENOMENAL FIND OF FLUID-BEARING QUARTZ CRYSTALS.

In a paper read before this Academy in January last, on the emeralds from Alexander County, North Carolina, mention was made of certain remarkable crystals of quartz found associated with them.

These quartz crystals having shown various peculiarities rarely observed, I have thought the recounting of these phenomena would perhaps be of interest.

Crystals of quartz containing inclusions of fluids and gases are not uncommon, though crystals having such inclusions plainly visible to the naked eye are rarely found.

The quartz crystals from Western North Carolina have attained a

wide celebrity from the fact of their inclusions being of remarkable size. In some cases they were wholly unprecedented.

Mr. GEORGE W. HAWES, in an exhaustive paper upon the liquid inclusions in quartz (Am. Jour. Sci., March, 1881), mentions Branchville, Conn., as furnishing massive quartz containing a greater number of included cavities than had before been observed, of which he gave a very thorough and valuable description. He also mentions, as noteworthy, cavities two mm. in diameter, from Fibia, St. Gothard, and those of 5 mm. in diameter, from Pike's Peak, Colorado. From Herkimer county, N. Y., I have seen crystals having inclusions of even 10 mm. in their longest diameter, though such crystals were of great rarity.

Before recounting the size of the remarkable inclusions in the North Carolina crystals, it might be well to describe the position of the "pocket" in question, and its relation to the rock in which it occurred.

It was while prospecting for new veins bearing emeralds, that this pocket was unexpectedly discovered. A narrow drift of quartz fragments, with small flakes of mica, was the only exterior sign noticeable. At the head of this drift, a shaft was located and sunk to a depth of nineteen feet, with the following interesting results.

The drift, within a foot of the surface, took shape as a solid vein of quartz, which rapidly widened until, at six feet depth, it had attained a width of fully three feet. Within the next two feet, the pocket nature of the vein had become apparent, by the presence of hard lumps of red clay, within which small crystals of quartz were found.

The vein for the next foot was almost entirely composed of this hard red clay. Then, to our great astonishment, one of the miners, striking his pick very forcibly, saw it disappear wholly from his sight. Naturally he was alarmed. We all thought for a time the safest place was at the top of the shaft. Feeling from past experiences, at the locality, that a cavity of not very unusual dimensions was about to be opened to our view, we descended and resumed the work.

Procuring a long stick, I probed this cavity, so as to arrive at its size; this being a necessary precaution to work it out properly and safely.

It was thus shown that the pocket was about three feet wide, seven feet long, and at that time about three feet deep, though I could push the stick quite deeply into the clay at the bottom.

Exposing at full length the upper part of the cavity, it showed all along its sides and at the bottom stalactitic and stalagmitic forms of red mud.

The quartz, which at one time had completely lined the pocket, had, by process of disintegration, dropped into the open space below. It

was in the mud and clay in the bottom of the pocket that all the crystals subsequently found were discovered. Only at the very bottom were the walls found "in situ." This pocket differed in no respect from those commonly occurring in this region. They are all shrinkage fissures, situated in a counter direction to the strata, of very limited extent, and nearly perpendicular in position. The country rock is gneiss, trending N. N. W. and S. S. E., with a dip nearly vertical. A thick layer of soil everywhere mantles and conceals it from view. Three days of careful work, by our most trustworthy and painstaking miner, were spent in exhausting this pocket.

No mineralogist could have been more careful in preserving the angles and edges of the crystals than was this miner. Not one crystal of the hundreds taken out was in any way injured.

Over four hundred pounds of *choice* quartz crystals were obtained from this one pocket, besides the nine emeralds previously spoken of and exhibited before this Academy. Of good, bad, and indifferent, there was found in all nearly half a ton.

It was noticed that all the crystals that had been directly attached to the walls were semi-transparent and without any great development of the prismatic faces; while, implanted upon them, were crystals of great beauty and transparency, varying from citrine-yellow to dark chocolate-brown in color, and for the most part perfect in form. Two-thirds of them were perfectly terminated at both extremities and with considerable prismatic development. It was these latter that contained the fluid-inclusions.

Large plates of rosetted mica were quite common, and on them were implanted small crystals of rutile and of quartz, in rare perfection. It is to these smoky crystals, found in this pocket, that I now ask your attention. When the smoky crystals were first found, they were noticed to contain many cavities seemingly filled with a very clear and lustrous fluid. Though no bubbles of air (or gas) were observed to move in these cavities at that time, yet I knew these crystals to be the so-called "water crystals" of mineralogists.

I take pleasure in recording the remarkable size and quantity of the cavities enclosed in these crystals. The longest cavity noticed was nearly *two and one half inches long* and one quarter of an inch wide. Cavities of one inch were not uncommon, while those of one quarter inch and less were, in truth, without number.

Many of the crystals seemed to be made up almost wholly of cavities, whose walls were barely thick enough to keep them separated. Many hundred, plainly visible to the unaided eye, could have been counted in a single crystal.

For some time after these crystals were removed from the pocket, no

bubbles were noticed in any of the cavities. Some peculiar condition of the crystal, or of the atmosphere, then existing, probably prevented their formation. Later, the bubbles appeared in great numbers. A few of the crystals were, as water-bearing crystals, very remarkable in size. One weighed nearly twenty-five pounds, had both ends terminated, was of a dark brown color, and as beautiful as any we have seen from other localities. All the water-bearing crystals were large, none less than two inches in diameter and many of over three pounds in weight. The cavities were arranged parallel to each other and to either a rhombohedral or a prismatic face.

The interesting phenomena I observed in these crystals did not occur until some time after their discovery. The best crystals of the "find" were carefully selected and placed where they were considered to be safe—safe at least from molestation. That the weather would interfere, or in any way affect them, did not enter my mind.

One evening in November last (the "find" occurred on Oct. 24), I left these crystals nicely arranged at the mine, except a few of the smaller ones, which I carried to my log-cabin home, thinking the while of what a treat I had in store for mineral collectors and for science. I will frankly confess that I was inordinately proud of my "find"—verily, "pride goeth before destruction."

Now, it is of the *destruction* of these crystals that I must speak. During the night following, the mercury unexpectedly descended below the freezing point. About midnight I was awakened by several sharp reports, like the explosion of gun caps. Over a dozen of these explosions occurred.

In the morning the family were curious as to the cause of the strange explosions heard in the night. Upon the table, where the crystals had been placed the evening before, there remained now only some few sharp fragments of quartz. Pieces of the crystals, large and small, were found even fifteen feet away. In fact they were completely ruined and now possessed only the interest of reminding one of what had been. The cold had caused the water in the cavities to freeze, and consequently to expand, and then burst the crystals.

I returned to the mine with the gravest fears for the safety of the finer crystals left there. Judge of my dismay to find not one of them, even the smallest, left intact.

Crystals, that only a few hours before were rare examples of the workings of Nature's laws, were now, by these same mysterious laws, left only as an evidence of her power to do and to undo her grandest achievements. Only crumbled masses of fragments remained to tell the story.

Those with few cavities had burst, scattering large fragments, widely

separated; while those containing minute cavities lay as a heap of small fragments frozen together, *in a coherent mass.* This last feature, while being a sad reminder in one respect, is of value to science, since it shows conclusively the abundance of the fluid included; and also, what is of more importance, that this cementing ice was formed either directly from the fluids *in the crystals,* or by influences which they exerted. I do not believe this cementing ice was wholly formed by the freezing of the water contained in the cavities, but was gathered there by the attractive influence of the liquid carbon di-oxide upon being so suddenly set free; that this liquid carbon di-oxide did, by its natural affinity for moisture, create around it an atmosphere so cold that even the little dampness then existing in the air was congealed upon the crystal fragments.

As the room was a dark one, I had all these masses and larger fragments carried out and placed in the sunlight, for no other reason than to examine them more carefully. I did not anticipate from this any further developments of scientific interest. Again, believe my astonishment, as soon as the rays of the sun touched them, to notice an ebullition commence at once, which, strangely, could be heard a few feet away.

I noticed in some of these masses a very distinct odor of sulphuretted hydrogen, which was quite fugitive in some of the pieces, while constant in others. This ebullition was continued for over an hour, growing less as thawing progressed.

While holding a mass of frozen fragments, my hand would become quite wet with the melting ice. I am not in error in stating that a cub. cm. of this fluid could have been easily saved, had the proper means been at hand. It is much to be regretted that none was preserved.

Mr. A. W. WRIGHT, in a paper following that of Mr. HAWES, already referred to, gave some valuable data in regard to the composition of fluid-inclusions in quartz. The following is a summary of his results:

He found "that smoky quartz, on heating, entirely lost its color, and that this color was due to the presence of a hydrocarbon of the nature of bitumen."

Aside from this bituminous matter, which is not known to be specially connected with the cavities in the quartz, he obtains the following analysis:

Carbon di-oxide	98.33
Nitrogen	1.67

with traces of sulphuretted hydrogen, sulphuric acid, ammonia, fluorine and probably chlorine.

The results of his investigations showed that the contents of these

cavities are chiefly water and carbon di-oxide, with a small proportion of nitrogen.

I noticed some curious phenomena in a single fragment, which had by some means escaped destruction by freezing.

This specimen had several small cavities, arranged nearly parallel to each other. At temperatures below 70° a small bubble could be plainly seen to move in each cavity, as the position of the specimen was changed. It was further noticed that the cavities contained two liquids, in one of which the bubble was wholly confined in its movements. This was seen to be the central and more transparent fluid.

If this specimen was slightly heated (the mere heat of the hand was found sufficient), the bubbles would grow gradually less until they disappeared entirely, and the fluids would unite.

On cooling, a critical temperature would be reached, when all the cavities would be filled with numberless minute bubbles, which, rushing together, would in a few seconds form to its full size the bubble originally noticed. I found that this experiment could be repeated indefinitely, without any diminution of its interesting phenomena or risk of damage to the specimen.

To Alexander county, North Carolina, and to many of the surrounding counties, we can hereafter look to produce fluid-bearing quartz crystals second in interest to those of no other region in the world.

[Mr. HIDDEN'S communication was illustrated with a very striking series of inclusion crystals, and of the fragments split off by the frost from the large crystals, as described. The pieces were in the form of large flakes or plates, parallel to the faces of the rhombohedron, and were clouded and filled with elongated or rod-shaped cavities, in immense numbers and of conspicuous size.]

March 13, 1882.

SECTION OF CHEMISTRY.

The President, Dr. J. S. NEWBERRY, in the Chair.

Thirty persons present.

Prof. D. S. MARTIN, in behalf of Mr. KUNZ, exhibited a series of crystals of Diopside, from the town of DeKalb, St. Lawrence Co., N. Y. This variety of pyroxene has never before been discovered, it is believed, in this country, though long known from the two localities of Ala and Traversella, in Piedmont. Its occurrence here is therefore, a matter of much interest; and the beauty and transpa-

rency of the crystals, and their perfection of form, render them quite remarkable.

Mr. ARTHUR H. ELLIOTT then read the following paper, which was largely illustrated with specimens of the various forms of apparatus described, and by experiments:

THE METHODS OF ASCERTAINING THE SAFETY OF KEROSENE OIL.

Before speaking of the various methods that have been proposed, and are now in use, for ascertaining the safety of kerosene oil, it will perhaps be well to look over the conditions of the problem. As we all know, kerosene oil is the product of the distillation of crude petroleum. This crude petroleum is made up of a number of oily liquids having different boiling points—in other words, liquids that give off vapors at different temperatures. These temperatures vary from 65° to 400° or 500° F. From 100 parts of crude petroleum there is obtained by distillation, in round numbers:

Benzine, Naphtha, etc., ... 15–16 parts.
Kerosene Oil, ... 55 parts.
Paraffine, Lubricating Oils, etc., ... 30 "

It will thus be seen that only about half the crude petroleum is fit for burning. For the benzine, naphtha, etc., are too volatile and dangerous, while the paraffine is only fit for lubricating, being too thick to flow through an ordinary lamp-wick. On account of these two facts, the kerosene oil is the most valuable product of the distillation of crude petroleum, and brings the best price in the market. Benzine is worth only half as much as kerosene oil, while naphtha and paraffine bring only one-third as much.

From these circumstances it follows that in distilling crude petroleum, the oil-refiner tries to get as much kerosene oil in his product as possible. To increase the quantity of kerosene oil given by the petroleum under treatment, the refiner may do one or both of two things. He may collect as kerosene those products which boil at either a lower or a higher temperature than good kerosene. The latter action is not so important as the former. In the last case an oil is obtained that is too thick and heavy to burn in ordinary lamps, and does not give a brilliant light. But in collecting the naphthas, which boil at a lower temperature than good kerosene, several very important results are produced. Besides adding to the quantity of kerosene in the products, these low boiling oils increase very much the brilliancy of the light given by the kerosene. Here let me state exactly what I mean by this expression. I do not mean to say that the amount of light obtainable from a given quantity of low-boiling oil is greater than that obtained

from a higher-boiling oil ; but that the intensity of the light given by the low-boiling oil is greater than that given by the high-boiling oil. When these low-boiling oils are allowed to mix with the kerosene, it will be seen that they give brilliancy to the light, besides adding to the quantity of product obtainable from a given crude petroleum. This is the commercial side of the question. Now let us look at it from another standpoint—that of the consumer. These low boiling-oils give off vapors, and these vapors, when mixed even in a small proportion with air, form explosive mixtures. Then comes the problem to be solved in ascertaining the safety of kerosene oil. At what temperature does a given sample of oil give off inflammable vapors ? And at what temperature must such a sample *not* give off these vapors? The latter question has already been determined and varies in different States of the Union ; some consider 100° F. as sufficiently high ; others require that the oil shall not give off inflammable vapors below 140° F. These temperatures have been fixed upon after experiments made with burning lamps, the details of which I will not trouble you with. Having decided at what temperature an oil shall not give off an inflammable vapor, it becomes necessary to fix the conditions under which the oil shall be tested, to determine whether it is or is not giving off this inflammable vapor. For this purpose, quite a number of pieces of apparatus have been devised ; and in experimenting with these, I have reached some results that may prove not uninteresting.

The various forms of apparatus used in testing kerosene for inflammability, and the presence of inflammable vapors, may be divided into two classes : first, those in which the safety of the oil is determined in an indirect manner ; and, secondly, those where the direct ignition of the vapors evolved is resorted to.

In the first class, we have the apparatus of Salleron and Urbain, of Paris ; where an attempt is made to determine the presence of inflammable vapors by finding the tension of the vapor of the oil at any given temperature, the idea being that the oil containing naphtha, benzine, and the low-boiling oils, will give a vapor-tension greater than an oil without these lower products. But, unfortunately, the apparatus devised for this purpose does not give reliable results, and is of little value.

Another experimenter has sought to determine the safety of kerosene by obtaining the index of refraction of light, when transmitted through a given sample of oil. But experiments have proved that there is no direct relation between these indices and the quantity of low-boiling oil present in a sample of kerosene ; indeed, the results are utterly valueless in the question of safety.

The second class of apparatus, in which a direct ignition of the

vapors is obtained, may be again divided into, first, those where the oil-surface is exposed, and called "open testers," and, secondly, those where the oil-surface is more or less covered, and called "closed testers."

Of these two divisions, the open testers are the first that were made and used. About twenty years ago Tagliabue devised his open petroleum-tester. It is a very simple affair, and consists essentially of a glass cup to hold the oil, which fits into a vessel of water that can be heated slowly. Having filled the glass cup with oil, a thermometer is hung in it and the whole is placed in the vessel of water; the latter is heated, and a small flame is constantly brought near the oil until a blue flash passes over the whole surface; the thermometer is now noted, and the temperature at which the blue flash appears is called the "flashing point" of the oil.

There are many details that affect the "flashing point" of an oil on this apparatus. Among these, I would mention the fact that rapid heating of the oil will lower the "flashing point," and also that the quantity of oil in the cup and the distance of the ignition-flame from the oil-surface cause the same result.

While experimenting with this apparatus, I have noted a phenomenon which has a bearing upon the safety of kerosene oil. If the apparatus is used in a very quiet room with no air currents, on approaching the oil-surface with a flame from time to time, it will be noted that, as the oil becomes heated, a temperature is attained at which the flame used for ignition becomes perceptibly larger and has a bluish outer envelope, which is very distinctly seen. This bluish exterior of the ignition-flame is very characteristic, and is noted many degrees below the flashing point of the oil in this apparatus. A very little thought will show what this phenomenon means. It will be observed that this blue extension of the flame becomes more and more marked until the oil "flashes." It thus appears that, as soon as the flame begins to enlarge, the oil is giving off inflammable vapors, but not in sufficient quantity to produce a "flash" on the surface. The vapors given off before the oil "flashes" are so light and easily diffusible that they are lost before they can form an explosive mixture with the air, for the flash is nothing more or less than a miniature explosion upon the oil-surface. Not until the vapors become so dense that they cannot diffuse rapidly, will the oil flash. The importance of this fact will be apparent later in this paper.

In testing oil with open testers, efforts have been made to produce uniform results by filling the oil-cup always to the same level, and also by various devices to obtain an ignition-flame of a given size and at a given distance from the oil surface. The ignition-flame has been replaced by the electric spark, as in the apparatus of SAYBOLT; but

neither this, nor any mechanical arrangement of flame, can overcome the difficulty of losing the lighter vapors in the open apparatus.

We will now discuss the question of "closed testers." In these an effort has been made, with more or less success, to prevent the escape of the lighter vapors lost in the open apparatus. Tagliabue, who made the first "open tester," has also devised a closed apparatus. In this he has simply placed a heavy brass cover, with a system of valves and a little chimney for igniting the vapors in, upon his open tester. The apparatus is not much better than an open tester, and has many drawbacks. First, it is extremely difficult to clean, since the valve-system below the cover dips into the oil, and it is impossible to clean the apparatus after using it with one sample of oil, and before using it with another. Secondly, the results obtained with this apparatus are but slightly lower than those obtained with a good open tester. In using the closed tester of Tagliabue it was noted that the enlargement of the flame took place at almost the same temperatures as in the open testers, the oil not flashing till many degrees above this point, a proof positive that this apparatus does not prevent the escape of the lighter vapors of kerosene. This last fact is partly due to the lack of space beneath the cover of the tester and the oil surface.

Fully realizing the importance of this whole subject, the English government appointed a commission to report upon the question; and the result of this report was an apparatus devised by Prof. ABEL, the chemist to Woolwich Arsenal. Prof. ABEL insures the slow heating of the oil by using a large quantity of water and by using an intermediate air-space between the water-bath and the oil-cup. The oil-cup has a point to be used as a filling-gauge, and is fitted with a tight cover, which carries the flame for ignition of the vapors. This apparatus certainly prevents the escape of the lighter vapors, but unfortunately the ignition lamp which is attached to the cover permanently, and is made of gun-metal, becomes very hot, and by communicating its heat to the cover raises the temperature of the oil at the sides and surface, and produces results that are too low; *i. e.*, this apparatus gives "flashing point" much lower than any other I have used, except MANN'S apparatus, which I shall speak of later.

A very ingenious type of "closed tester" is that devised by BERNSTEIN. This consists of a tube in the form of a letter U, which contains the oil to be tested. One limb of this tube is enlarged, and in it is fitted a cap containing two wicks, one central and the other at the side. Around the central wick is a tube communicating with the enlarged limb of the tube below, and the rest of the cap is closed. To operate this apparatus, the limbs of the tube are filled with water to the level of the bottom of the larger end; into the larger end a measured

quantity of the oil to be tested is introduced, the cap with the wicks is fitted, and the whole is placed in a vessel of water of the temperature at which the oil should *not* flash. When this temperature is nearly reached, the little wick on the side of the cap is lighted ; and when the thermometer reaches the standard temperature, a measured quantity of water is poured into the narrow limb of the U tube. By this action the level of the oil in the enlarged portion of the tube is raised, and any vapors that may be there are forced through the tubes around the central jet. These vapors meet the flame of the jet already lighted, they become ignited, and by so doing ignite the central wick.

It will be seen that as soon as the oil-level is raised, it is not easy to repeat the experiment ; hence the apparatus is only intended to determine at what temperature an oil does *not* give off vapors, and not to determine its flashing point. One important difficulty in this apparatus is the fact that the central wick will not ignite with certainty every time that an oil is giving off inflammable vapors. For I have repeatedly failed to ignite the central wick in an experiment, and on removing the cap have immediately obtained a flash with the oil in the cup. When the central wick ignites, this apparatus gives results that are generally higher than with open testers, which may be due to the fact that the vapors must have a certain density before their ignition will inflame the central jet.

One of the best of the recently devised forms of " closed testers " is that used in the State of Wisconsin. Its construction is very simple, but it embodies some features that make it stand before those I have already mentioned. It consists of a copper water-bath, a copper oil vessel, and a cover with two holes in it, through one of which passes a thermometer.

The oil-cup holds a good quantity of oil, and there is considerable space above the oil-surface for the accumulation of the vapors. Its use is very simple, and consists in heating the oil slowly by means of the water, the flash being obtained by introducing a small flame into the second hole of the cover. The apparatus is not costly ; it is easily used and cleaned, and the results obtained are quite near the truth.

Some years ago Mr. MANN conceived the idea that the best way to test oil is under the same conditions that obtain in using it. For this purpose he devised a metallic lamp, about the same size as an ordinary kerosene one ; he replaced the usual wick-holder by a tube, which could be loosely closed with a plug. The side of the lamp contained a valve opening inwards, through which a flame could be introduced to ignite the vapors. The thermometer was placed in a closed tube fitted into the side of the lamp. This lamp was placed in a water-bath that fitted it, and the whole heated slowly. A small flame (a gas-jet) was

introduced from time to time, until the plug was driven out by the force of the explosion of the mixture of vapors and air within.

At first sight this appears to be the acme of oil-toilers; but, alas, it has several important faults. It is not a matter of indifference how the plug is placed in the tube. If it is too tight, it will not be ejected by the explosion, and the flame will force itself out at the side valve. It is also important that the instant of right admixture of vapors and air should be the instant that the flame is introduced. For if the air contains more vapors than will form an explosive mixture, simple combustion at the valve, and not explosion, is the result. By introducing the electric spark as a means of ignition, the difficulty of admixture may be overcome; but the force necessary to eject the plug must always be a difficulty.

In this paper I have not been able to discuss all the various apparatus used for testing kerosene oil; but I have taken some of those most used, and that are types of others.

Yet one other apparatus remains to be noticed, and this is the "electric closed tester," devised by Mr. PEASE, of Buffalo. In this apparatus we have the usual oil-cup and water-bath. But the oil-cup has a cover, and an overflow tube to insure the level of the oil remaining the same during the process of heating; since the heating causes expansion of the oil and thus raises the level. Into the cover of this tester are fitted two wires, between which a spark from an induction-coil may be passed. The usual outfit of thermometers completes the apparatus.

This apparatus is very nicely made, and the overflow-tube is an important device, especially with the heavier oils. But, in working with this tester, I was surprised to obtain results very little better than with an open tester. This is due to the fact that the spark-wires are in the centre of an opening in the cover, and that this opening is so large that the vapors escape around the sides without being ignited. To prove this, I covered the opening with a small piece of glass, and obtained a flash at a much lower temperature, because the vapors could not escape.

For the sake of comparison, I have tabulated the results obtained with the various apparatus, and the quantities of oil used in each.

	Oil Used.	Flash.
Tagliabue's (open)	2 ounces	97° Fah.
Saybolt's (open)	2⅓ "	99 "
Tagliabue's (closed)	3 "	93 "
Abel's (closed)	2½ "	76 "
Bernstein's (closed)	1¾ "	100 "
Wisconsin (closed)	5 "	86 "
Mann's (closed)	10 "	75 "

Looking at the above table, and rejecting the results from the apparatus of both BERNSTEIN and ABEL, which are faulty in construction, the following conclusions may be drawn:

1. Open testers are not to be recommended, since the light vapors are lost.

2. Closed testers should be so constructed as to prevent the loss of vapors, and to give conditions that obtain in burning an ordinary kerosene lamp. This last fact is important in connection with the quantity of oil used. A glance at the table reveals the fact, that the greater the quantity of oil in the apparatus, the lower the "flashing-point." It is ridiculous to make a test on two ounces of oil, which is used in a lamp holding twelve or more ounces. The test should be made upon at least ten ounces of oil, and in an apparatus where the personal equation of the operator shall have little or no influence.

The paper of Mr. ELLIOTT was discussed at some length by Prof. SEELEY, Dr. NEWBERRY and Mr. WOLCOTT.

March 20, 1882.

LECTURE EVENING.

The President, Dr. J. S. NEWBERRY, in the Chair.

The larger hall was entirely filled.

Ordinary business of detail was omitted; and the regular lecture of the monthly course was delivered by Prof. JOHN K. REES, on the subject of—

SOME RESULTS OF PHOTOGRAPHY AS APPLIED TO ASTRONOMY.

(Abstract.)

We find Mr. NORMAN LOCKYER, of England, stating in his book on "Star-gazing," that "celestial photography was founded in the year 1850 by Prof. BOND of Cambridge, Mass., who obtained daguerreotypes of the moon at about that date." This appears to be an error. Dr. HENRY DRAPER, of this city, in a paper published by the Smithsonian Institution, tells us that the first photographic representations of the moon ever made, were taken by his father, the late Prof. JOHN W. DRAPER. Prof. DRAPER presented his specimens to the New York Lyceum of Natural History. In the minutes of that body we find the following memorandum:—

MARCH 23, 1840.—Dr. DRAPER announced that he had succeeded in getting a representation of the moon's surface by the daguerreotype. The time occupied was *twenty minutes*, and the size of the figure

about one inch in diameter. DAGUERRE had attempted the same thing, but did not succeed. This is the first time that anything like a distinct representation of the moon's surface has been obtained.

(Signed) ROBT. H. BROWNNE, *Secretary.*

Since that time celestial photography has been immensely improved. When we read the names of the men who have done the most to develop this beautiful branch of investigation, we find that a member of the New York Academy of Sciences stands at the head.

To LEWIS M. RUTHERFORD the world of science owes a great debt for his untiring perseverance and ingenuity, shown in developing Celestial Photography to such a point that it now bids fair to replace, in a great measure, all other methods of observation.

[The general outlines of the method of photography were given, the several obstacles to be overcome were mentioned, and the plate-holder illustrated and explained. The necessity of having a good clock was shown. The differences between reflectors and refractors for photographic work were illustrated, several advantages of each kind of instrument being mentioned.]

As a piece of interesting history relating to our subject, let me quote from an English work, Chambers' Descriptive Astronomy.

"To an American we are indebted for the best pictures of our satellite yet produced, and it is difficult to conceive that anything superior can ever be obtained; and yet with the fact before us that De la Rue's are better than anything taken in this country, so it may prove that even the marvellous pictures of Mr. RUTHERFORD may be surpassed."

Mr. RUTHERFORD appears, from a paper in SILLIMAN'S *American Journal of Science* for May, 1865, to have begun his work in lunar photography in 1858, with an equatorial of 11¼ inches aperture and fourteen feet focal length, and corrected in the usual way for the visual focus only. The actinic focus was found to be $\frac{7}{10}$ of an inch from the visual. The instrument gave pictures of the moon, and of stars down to the fifth magnitude, satisfactorily, when compared with what had been done previously, but not sufficiently so to satisfy Mr. RUTHERFORD. After trying to correct for the photographic rays by working with combinations of lenses inserted in the tube between the object and the sensitive plate, he commenced some experiments, in 1861, with a silvered mirror of 13″ diameter. This was mounted in a frame and strapped to the tube of the refractor. Mr. RUTHERFORD enumerates several objections to the reflector for this kind of work, but admits the advantage of coincidence of foci. The reflector was abandoned for a refractor, specially constructed, of the same size as the first one and of nearly the same focal length—about $\frac{1}{10}$ shorter. This instrument was corrected for the chemical rays only, and was, therefore, worthless for

seeing. The glass was completed in December, 1864; but it was not until March 6 of the following year that a sufficiently clear atmosphere occurred, and on that night the negatives were obtained, from which the pictures of the moon that we shall see to-night were taken.

But even with this method Mr. RUTHERFORD was not satisfied. Coming back to the 11¼-inch object glass which he had used at first, he determined to see whether or not the addition of a meniscus lens, outside the front lens, would not give him the requisite shortness of focus and bring the actinic rays absolutely together. By this arrangement he got a telescope which can be used for all purposes of astronomical research, and he has also eclipsed all his former efforts.—(*Lockyer, Star-gazer*, p. 467.)

In the series of moon-pictures by RUTHERFORD and DRAPER, we have a complete map of the moon; not only are the grander outlines clearly shown, but many of the smaller details. [Illustrations were given of the work of BEER and MAEDLER, of Germany, and SCHMIDT, of Athens. Comparisons were made between the photographs and eye-drawings, and the use of photography in detecting changes in the moon was alluded to.]

In taking sun-photographs, it becomes necessary, on account of the dazzling brightness of the sun's light, to make the exposure practically instantaneous. Some astronomers reduce the aperture of their telescopes, by suitable diaphragms, to about two inches diameter, thus cutting off a great deal of the sun's light. Even then, the time of exposure is less than the three hundredth part of a second. [The method of making these quick exposures by what is called the instantaneous slide was explained. A series of pictures of the sun, by MR. RUTHERFORD, was then thrown on the screen. The use of photography, in studying the mottled surface of the sun, was illustrated by photographs from RUTHERFORD and JANSSEN, and drawings from NESMITH, SECCHI, HUGGINS and LANGLEY.]

There are times when the sun shows us surroundings which it is impossible to see ordinarily, as at total solar eclipses. Such a time is an exciting moment, the eclipse lasting from a few seconds to some six or eight minutes only, and the average time being such that altogether we have only a few days in a century for observation. Drawings made by two observers, side by side, differ very peculiarly. Photography assists us immensely in our study, and some of the best observations of eclipses have thus been made. [Illustrations of the photographs of 1851, 1860, 1869, 1870 and 1872 were then thrown on the screen and explained. A full description was given of the apparatus used by the American parties, in photographing the transit of Venus, and some illustrations of actual photographs taken were shown.]

But not only are we able, by the aid of photography, to study the members of the solar system, but it is possible thus to investigate the relations of the immensely far-off stars, and even to determine their distances.

In the heavens we discover with a telescope that many stars are changing their positions and distances with respect to their near visible companions; and investigations have been made proving that some of these revolve about the others as centres, forming systems of their own, like our solar system.

The measurements required for this work are numerous and delicate, and can be made only on nights when the seeing is very fine, by a skillful observer. Mr. RUTHERFORD has adopted a method of photographing a cluster of stars, or a double star, in such a way, that the plates can be laid away and measured by a person simply trained in the use of a micrometer. These plates may be taken at large intervals. On comparing the measurements, a decision can be reached as to whether any stars have moved with respect to the others.

Let me describe Mr. RUTHERFORD'S method:

First, a wet plate is exposed for four minutes. This gives stars down to the tenth magnitude. But there may be points on the plate which are not stars; hence a second impression is taken on the same plate, after it has been slightly moved. All points now doubled are true stars. Now for measures of arc. After this second photograph is taken, the clock is stopped. The now moving stars down to the fourth magnitude are bright enough to leave a continuous line; the length of this, in a very accurately known interval, say two minutes, enables the arc to be calculated. Next comes the mapping. The negative is fixed on a horizontal divided circle on glass, illuminated from below. Above it is a system of two rails, along which travels a carrier with two microscopes, magnifying fifty diameters. By the one in the centre, with two cross-wires in the field of view, the photograph is observed. By the other, armed with a wire micrometer, a divided scale, on glass, which is fixed along the rail, is read. Suppose we wish to measure the distance between two stars on the plate. The plate is rotated so that the line which joins them coincides with that which is described by the optical axis of the central microscope (marked by the cross-wires), when the carrier runs along the rails. This microscope is then brought successively over the two stars, and the other microscope over the scale reads the nearest division. Hence then, the fixed scale, and not a micrometer screw, is depended upon for the complete distance. In this way the distance between two stars on the plate can be measured to the $\frac{1}{12500}$th part of an inch.

By the measurement of such plates, we may hope to add a great deal to our knowledge of the stellar systems.

March 27, 1882.

SECTION OF PHYSICS.

The President, Dr. J. S. NEWBERRY, in the Chair.

Mr. GEORGE F. KUNZ showed specimens of marine shells (*Pectunculus*, etc.,) from "Aztec" ruins, near Salt River, Arizona, curiously cut or ground into ornamental articles, by the ancient occupants of that region.

The PRESIDENT read some notes furnished by Dr. J. B. HOLDER, in reference to the whale on exhibition at the foot of Wall street, recently captured off Montauk. He was disposed to regard it as a specimen of *Eubalæna Sieboldii*, a species belonging to the North Pacific; and, in this case, it would seem that the animal must have reached this coast by making the "northwest passage."

Mr. ARTHUR H. ELLIOTT reported for the committee appointed to prepare a memorial of the late Dr. HOLLEY; he read the following paper, which was adopted by the society and ordered to be published in the transactions:

In Memoriam.

ALEXANDER LYMAN HOLLEY, the widely esteemed fellow of the New York Academy of Sciences, was born at Lakeville, Conn., July 20, 1832. His father was once Governor of the State, and still lives at Lakeville, at the age of 77. The son, at an early age, conceived a passion for the profession that was ultimately to make him famous, and learned the trade of a machinist. He was prepared for Yale College; but, having a scientific turn, he entered Brown University, and graduated from the scientific department in 1853, at the age of twenty-one. His graduating address, on "Motive Power," shows that he was still true to his first tastes for engineering and its branches. After graduation, he entered the Corliss Works at Providence, R. I., in the double capacity of workman and student; and afterward became a locomotive engineer on the Stonington and Providence railroad. From this position, he went to the New York Locomotive Works of BREESE, KNEILAND & CO., at Jersey City, as draughtsman; and became a contributor to several technical journals. In 1856, he was owner and editor of the *Railway Advocate*. In 1857, he went to Europe to study railroad practice there; and in 1858, he published, in connection with ZERAH COLBURN, their celebrated book on European railroads. During this time Mr. HOLLEY was an active professional writer for the New York *Times*, and foretold at that day the supersedure of the side-wheel

by the screw, in ocean steamers. In 1859, he went to Europe with Mr H. J. RAYMOND, as correspondent for the New York *Times*, and met BRUNEL and SCOTT RUSSELL, the projectors of the "Great Eastern," which vessel he studied, and returned to America in her on the first trip. When writing for the New York *Times*, it was under the *nom de plume* of Tubal Cain.

About this time we also find him editing the *American Railway Review*; and in 1860, he published "Railway Practice." In the year 1862, he went to Europe to investigate ordnance and armor, in behalf of Mr. E. A. STEVENS of Battery fame; and the result of this visit was a book on these subjects published in 1865, which was translated and published in France. During this time (in 1864), he contributed 1000 definitions and several hundred figures to Webster's Dictionary.

While in England, studying ordnance and armor, he met Mr. HENRY BESSEMER, and became interested in the process of making steel, which was to render his name most famous, and give America the foremost position in the world in the manufacture of this indispensable material.

BESSEMER first announced his discovery of making steel by blowing air through molten iron, in the year 1856, at the Cheltenham meeting of the British Association for the Advancement of Science; and HOLLEY was among the first to appreciate its value. In 1862, he first became identified with this process of manufacture; and his connection with it became a series of engineering triumphs almost without parallel, till his death.

The first steel works in the United States to use the BESSEMER process were those at Troy, and the first ingot of metal was cast in 1864. Three years later the works at Harrisburg were built by Mr. HOLLEY, and he managed them till 1869. He rebuilt the Troy Works and planned the works at North Chicago and Joliet, Ill., the Edgar Thomson Works at Pittsburg, and the Vulcan Works at St. Louis. From the trial ingot cast at Troy in 1864, the industry has grown until the product of a year now amounts to more than a million of tons. And this gigantic industry owes much of its success to the active brain and patient industry of MR. HOLLEY.

In the year 1877, he was made consulting engineer to the Bessemer Steel Association of America, and became the idol of the manufacturers. He was a fine speaker and a ready wit, and there was that in his discourse that made his sentences always pleasing to the ear. From 1875 to 1876, he was President of the American Institute of Mining Engineers. During the following year, he was Vice-President of the American Society of Civil Engineers; and, in 1879, he organized and became first President of the American Society of Mechanical Engin-

eers. He was also a member of the United States Commission for testing iron and steel.

Since 1872, he has written eighteen papers for various societies, contributed to SCRIBNER'S *Monthly Magazine*, and last, but not least, became Lecturer on Iron and Steel at the School of Mines of Columbia College. In the latter office, he was beloved of all the students who had the good fortune to hear him. His calm delivery, his carefully rounded sentences, and his pre minently practical manner of treating his subject insured an amount of attention that few lecturers enjoy. The kind answer to a question, the evident endeavor to put himself in the student's place as an inquirer, made him attractive to all, and his lectures were looked forward to, as hours of intellectual enjoyment and profit. He died in Brooklyn, January 29, 1882, from peritonitis, and lies buried in Greenwood Cemetery.

Such is a very brief record of a life that was busy beyond comparison. As a mechanical engineer, a railroad engineer, a military engineer, or a metallurgical engineer, Mr. HOLLEY could claim a position among the greatest; but when we reflect that he was eminent in each of these branches of the science of engineering, we stand bewildered at the power of brain, and the untiring energy that carried him to such a height. As a proof of his greatness, there is not to-day a man who can at once fill his place in the engineering world. But it cannot be doubted that he was prodigal of his strength, and often did more work than his wonderfully vigorous mind could bear. The tenacious metal, that he loved so well, would scarcely have been tough enough for the body to carry such a mind, and the intoxication of vigor often leads the best of us to feats of endurance from which in our calmer moments we shrink.

From every steel-works in America, from the glowing throat of every converter, there comes a radiance directed to but one point, the illumination of the name of ALEXANDER LYMAN HOLLEY; a name not to be forgotten where the watch-spring or the suspension bridge are born of American steel.

ARTHUR H. ELLIOTT, } *Committee.*
THOMAS EGLESTON, }

Prof. THOMAS EGLESTON then presented the regular paper of the evening, entitled:

THE PROPOSED GOVERNMENT COMMISSION FOR THE TESTING OF IRON AND STEEL.*

* Published in Trans. Inst. Mech. Engineers, Phila. meeting, Feb., 1882

April 3, 1882.

REGULAR BUSINESS MEETING.

The President, Dr. J. S. NEWBERRY, in the Chair.

There was a large attendance, occupying the new lecture hall.

The report of the Council was read, recommending the election of the following persons as Resident Members:

GEORGE GREGORY, GEORGE F. STEVENS;

and they were thereupon unanimously elected.

The Council also recommended, and the Academy voted, the change in the subscription price of the Annals, suggested by the Publication Committee, viz., from $2.00 a year to the following rates:

To resident and honorary members, two dollars a year, as before.

To others, non-residents of New York City, three dollars.

To residents of the city who are not members of the Academy, five dollars.

Dr. GEORGE M. BEARD presented the paper of the evening, entitled:

A PSYCHOLOGICAL EXPLANATION OF THE SALEM WITCHCRAFT EXCITEMENT, AND THE PRACTICAL LESSONS TO BE DERIVED THEREFROM.

(Abstract.)

Dr. BEARD sketched briefly the facts of the celebrated "Salem witchcraft," and referred to the views now generally held, which have regarded it as a combination of deception, delusion, superstition and bigotry. He claimed that much in these views ought to be modified in the light of modern scientific research, and also of historical justice. He had sought to study the matter impartially, from the standpoint of scientific psychology; and after reaching conclusions which gave to his own mind a much clearer understanding of the whole phenomenon, he had visited Salem and gone over the ground as carefully as possible, only to find his conclusions more firmly established. In his view, many of the facts, alleged upon the trials of accused persons at Salem, find their explanation—now for the first time—in well-marked symptoms of the trance state, then wholly uncomprehended, and even now but little known save to specialists in that department. The men who tried and condemned the unfortunate victims of this melancholy affair were neither fools nor wanton persecutors; they were among the most cultivated

and earnest men of the colony, and acted under a profound, though most erroneous, sense of responsibility. They are not to be denounced as judiciai murderers of their friends and townspeople, as has been often, and unjustly, done, but must be looked upon as honest and earnest, though sadly mistaken and unenlightened men.

A large part of the testimony on these trials consisted of that given by various young persons—the so-called "afflicted children"—to the fact of their having been bewitched by certain suspected individuals; and these children would be seized with convulsive movements upon being confronted with the persons charged. Here was, apparently, the most positive evidence, plain to all, and given before the eyes of the judges. No other explanation was then known of such facts than that of actual sorcery, which was universally believed to be the result and manifestation of an accursed compact with a personal Evil Spirit. For such diabolical intercourse, the penalty was death; and with such clear evidence of fact, and with no other explanation of those facts known or imagined, both law and logic forced the judges to condemn the accused to death.

(Dr. BEARD here produced two lads, liable to the trance condition, and called their attention to the President of the Society, occupying the Chair; first one and then the other, with no apparent cause, went into convulsions, from which they were recalled in a moment or two by Dr. BEARD, and helped into chairs, where they very speedily passed into a state of sleep.)

Here, remarked the lecturer, we have illustrated the case of the "afflicted children." He read passages from the records of the trials, where precisely such manifestations took place. The accused persons would solemnly deny the exercise or possession of any diabolical arts. They would then be asked how it was, in that case, that these children were thrown into such a state, on merely being confronted with them. To this they could give no answer, save that they knew not indeed, but that still they were innocent. The condemnation of the accused was then a logical necessity, to the belief of that time. Those who confessed were pardoned or let off with a lighter penalty; but those who denied, and protested their innocence, were sentenced to death as witches.

The only ground on which this mournful and tragical result could have been avoided, in the state of knowledge and belief two centuries ago, was the question as to the validity of testimony given by those who were possessed or bewitched. This might have afforded an escape from the otherwise inevitable consequence, and it is much to the credit of the clergy of that time that they were strongly disposed to urge this doubt and to reject the evidence thus given. COTTON

MATHER distinctly expressed his serious concern as to the acceptance of such testimony. But the lawyers and judges were not to be shaken in their adherence to the rule of legal precedent; decision after decision was cited from the old English courts, admitting such evidence in trials for witchcraft, and the more cautious and humane disposition of the ministers was overborne by the stern and rigid influence of the law. Yet this, be it remembered, is the lawyer's rule of action. The judges were bound to conform to the precedents of former procedure; and however mournful the result, and however revolting to the sentiments and beliefs of a more enlightened age, yet the Salem judges were faithful to their professional rules and their official responsibility. We must judge them by these, and not by the standards of to-day.

The Salem witchcraft was the last chapter in the long and bloody record of trials for sorcery and necromancy, which casts its shadow over many a page of European history. It had already ceased on the Continent and in England, and here in the New World colonies it had this one tragical outbreak, and then exhausted itself never to recur. It is not claimed that the views here presented are the explanation of all that then occurred; there were in some cases sinister motives actuating persons who made charges; there was in other cases, perhaps, actual deception. But it is believed that a large part of the evidence, that was most critical and most convincing, can be explained, in the way here suggested, with great ease and naturalness; and it is moreover due to the men of that time, to bear in mind the ignorance of science amid which they lived and the bonds of legal precedent in which they were held, and so to clear their memory from unjust severity of reprobation.

DISCUSSION.

A long and active discussion, covering a wide range of subjects, arose after the paper of Dr. BEARD.

Dr. BENJAMIN N. MARTIN expressed his very profound interest in the views presented. At the same time he was inclined to believe that a good deal of the testimony referred to arose from the disposition of some children to mere mischief and trickery, for the amusement afforded them in perplexing and mystifying grave and elderly persons by odd devices and pranks. He cited recent cases of marvellous "manifestations," of ghostly china-breaking and unaccountable noises, etc., finally traced to mischievous children; and questioned whether much of the Salem evidence may not have been of this kind.

Mrs. ERMINNIE A. SMITH spoke of her studies and observations among the Indian tribes on the New York State Reservations, and

of the deeply-rooted belief in witchcraft, etc., that is to be found there, even where the people have taken on the externals of civilization. She proposed the question whether, in view of the credence given to spiritualism and the like among our own people, the claim of a great advance in culture and enlightenment, from these ruder, but kindred, superstitions, could be consistently maintained.

Dr. BEARD replied that, as regards spiritualism, it is precisely as Mrs. SMITH had said, a manifestation of the same kind; but the superstition is of a milder type, lacking the ferocious and tragical features that belong to the witchcraft delusion, and herein lies the advance and the improvement.

Several other members discussed various aspects of the paper of Dr. BEARD.

April 10, 1882.

The President, Dr. J. S. NEWBERRY, in the Chair.

Thirty-five persons present.

THE SECRETARY referred to the arrival, a day or two before, of the remarkably large African elephant, "Jumbo," sold from the London Zoölogical Gardens, on account of supposed vicious disposition. He noted certain of the differences between the two species of elephants, the African and the Asiatic—the former being reported as generally larger, and also readily distinguished by the great size of the ears.

THE PRESIDENT commented on the same subject, and illustrated by blackboard drawings the distinctive features of the teeth in the two species. The teeth of the Asiatic elephant, like those of our American fossil species, are crossed by parallel ridges of enamel and dentine; while in the African elephant the plates are waved in such wise as to produce not parallel, but lozenge-shaped ridges on the crown of the tooth.

Mr. F. G. WEICHMANN then read a paper entitled:

FUSION-STRUCTURES IN METEORITES.

(Abstract.)*

After referring in general to the peculiar interest which attaches to meteorites, and the uncertainty as to their real nature which is still felt

*This paper is printed in full in the ANNALS of the Academy, Vol. II, No. 10.

among scientists, Mr. WIECHMANN alluded briefly to four principal theories of their origin, as (a) Terrestrial Volcanic, (b) Lunar Volcanic, (c) Planetary, or (d) Cometary. There are many objections to the theories that regard them as belonging to the earth or its satellite, on the one hand, or as visitants from distant space, on the other; and preference is doubtless due to the view that these bodies belong to the planetary system—perhaps as fragments of asteroids that may once have collided. As regards the differences in their mineral and chemical characters, which have led to various classifications, that of DAUBREE alone was given. According to him, meteoric stones are divided into (1) Siderites and (2) Asiderites, according as they are composed of metallic iron (wholly or partly), or do not contain that substance. The former class, the Siderous meteorites, he again divides into Holosiderous, Syssiderous, and Sporasiderous—according to the amount in which the iron is present. Various analyses of meteorites were then given.

Mr. WIECHMANN next proceeded to his own researches upon meteorites, describing the manner of examining microscopic sections, and certain adjustments thereof with reference to the use of polarized light. A list of seventeen specimens was given, with the dates and localities of their fall, from which he had prepared and studied numerous sections, and also of various volcanic rocks examined in the same manner for comparison. His attention had been chiefly given to certain very peculiar and characteristic forms which are found in many meteorites, and to which he gave the designation of "*Fusion-Structures*."

These structures are not crystal forms, as they lack the definite angular character that belongs to the latter; their outlines are often rounded, and their aspect curiously suggestive of organic structures. They might fall under ZIRKEL'S definition of what he calls *crystallites*, i. e., mineral formations possessing a radiate arrangement or grouping, but not showing, either as a whole or in their parts, any regular properties or outlines of crystallized bodies. It is these "fusion-structures' which have been regarded, in the recent well known work of OTTO HAHN, as representing true organic remains.

The structures of this kind which Mr. WIECHMANN had found in the sections prepared by him, were then described, and illustrated by a series of very finely prepared drawings, displaying their characters as seen at various magnifying powers, from 75 to 1500 diameters. It was shown that, in some cases, the organic aspect, presented under a low power, disappears entirely upon greater magnification. After discussing these, the author declared his inability to discover any forms that seemed really organic, and criticised various points asserted in Dr. HAHN'S work, as distinctly negatived in his own observations.

The sections of volcanic rocks were then shown and described in the same manner as those of the meteorites had been ; and the interesting result was brought out, of a very close similarity in the microscopic structure of various specimens of these two classes of bodies. Whatever theory be held as to the origin of meteorites, that of volcanic rocks is sufficiently known and universally admitted : they have cooled from a state of fusion. If, therefore, a likeness of internal microscopic structure appears in the two kinds of bodies—besides in many cases a close resemblance in composition—we may safely conclude that meteorites also have passed through a fused condition, and that the structures in question have originated in them as they have in volcanic rocks.

Numerous other points were treated of in this paper, *e. g.*, the probable origin of the "crystallites" or "fusion structures" in igneous rocks, as due to unequal rates of cooling among the different constituents of the fused mass, resulting in the segregation of minute portions scattered through the rock ; also the effect upon meteorites of the friction-heat developed in passing through the earth's atmosphere, which effect is plainly shown in the sections, but is seen to be only superficial. For these and other details, reference must be made to the article as published in the Annals.

DISCUSSION.

Prof. R. P. WHITFIELD, DR. NEWBERRY and others discussed the paper briefly, agreeing with the views therein expressed, and welcoming its presentation, and also dissenting entirely from the views of Dr. HAHN, as to the presence of organic remains in meteorites.

April 17, 1882.

LECTURE EVENING.

The President, Dr. J. S. NEWBERRY, in the Chair.

A large audience was present.

CHEVALIER ERNST VON HESSE-WARTEGG delivered the lecture of the evening.

THE SUBMARINE TUNNEL BETWEEN ENGLAND AND FRANCE.

(Abstract.)

In regard to the necessity of such an enterprise, reference was first made to the well-known and very peculiar discomforts of the passage of the Channel in boats, and to the aggravation thereof by the poor construction and worse management of the steamers employed. In-

stances of these grounds of criticism were given as examples, and of the natural difficulties, moreover, which often involve great and unavoidable delays and irregularities in the transit of both passengers and mails. Under these circumstances, the great desirableness of some improved means of travel is apparent at a glance, when it is remembered that a country of 30,000,000 of inhabitants is to be connected with a continent of 300,000,000, and that some 700,000 passengers annually make this passage.

If the commercial aspect be regarded, it is found that the yearly interchange of products between England and the continent amounts to a hundred millions of pounds sterling in value, and employs vessels aggregating a tonnage of ten millions. There could be no question of the financial success of such an undertaking as the proposed tunnel, where so large a business in both freight and passengers is subjected to so many inconveniences. If America had been similarly situated, such a work would long since have been accomplished; but the conservatism and the political anxiety of the English people have interposed serious obstacles.

Some seven years ago the proposal was first discussed, and the financial and engineering possibilities were largely debated, but no political difficulties were then raised. Only of late has this aspect been presented, and a formidable opposition made to the construction of the tunnel, on the part of both the people and the Parliament of England. This objection the lecturer considered most unwise and unjustifiable, a selfish hindering of a great enterprise of general importance and advantage. The St. Gothard Tunnel, or the railway over the Pyrenees, would be open to the same objection of a possible political danger; but none of the nations thus connected had for that reason opposed these great works of intercommunication. Nothing could be easier or simpler than to guard the entrance to a tunnel, especially when that tunnel lies beneath the sea, and could be flooded and closed at the first intimation of a foreign invasion.

Turning to the scientific aspect of the work, reference was made to the character of the material in which the tunnel is to be wrought. This is found to be chalk throughout, the well-known chalk of the Dover cliffs extending under the channel all the way. The work of excavation is therefore easy; the question might arise, however, how far this soft rock would prove impervious to the water. This had been tested by careful experiments; and it was proved that, even under heavy pressure, a small thickness of chalk allowed scarcely any perceptible passage to water.

The construction of the tunnel was next described, and illustrated by drawings. Its general section-form would be that of a low horse-shoe,

nineteen feet in width by twenty-four in height. The whole would be lined with brick; but this brick wall and arch would not be quite in contact with the chalk excavation, but a space was to be left between, to allow any percolating water to pass down without entering the tunnel-way and escape beneath its floor. This escape would be secured by the slope of the tunnel, which is to be highest at the middle and descending somewhat toward each end, where large reservoirs will be excavated for any accumulating water, which will thence be removed by powerful steam pumps, raising it through shafts to the surface. The important matter of ventilation is to be provided for by engines at either extremity, so working as to insure a steady and powerful current of air through the entire tunnel, one pumping air, and the other exhausting it.

The machinery employed in the work of excavation was also referred to and illustrated; but it is peculiar and complicated, and cannot be well described, save at length and with figures. In working through the comparatively soft chalk, the process is strictly one of cutting; and a very ingenious and beautiful machine is employed, wherein a series of blades, like knives set upon revolving wheels, is made to cut the chalk at the extremity of the boring. The machine itself is also advanced on wheels, as it works onward the heading from day to day. Thirty-six feet is about the daily rate of progress; and it is computed that the whole will be finished in five or six years.

Estimates were then given of the profits which it is expected will be realized, if the work is successfully completed. The amount of funds requisite to do this will be forty to fifty millions of dollars; say, ten millions of pounds sterling. Three-fourths of the present passenger traffic should, it is altogether probable, prefer the tunnel to the channel voyage; and, considering the advantage in freight-transit of not "breaking bulk" for shipment, the receipts may be estimated roughly as follows:

Passenger travel	£850,000
Freight	300,000
Mail service, etc	50,000
Total	£1,200,000

Deducting from this, say, forty per cent. for expenses (£480,000), or somewhat less, there will remain a profit of £720,000, or more, which would yield from seven to seven and a half per cent. yearly on the capital of £10,000,000. If this capital seems large, it is not so in comparison with the sum already invested in the English railways, which amounts to about £700,000,000.

For his own part, the lecturer was fully convinced alike of the need,

the practicability and the financial success of this great enterprise; and he had no doubt that ladies and gentlemen now in his audience would yet pass through this submarine tunnel, on their way between Paris and London.

At the close of the lecture, complimentary remarks were made by the PRESIDENT and Dr. B. N. MARTIN; and on motion the interest and gratification of the Academy was expressed in a resolution of thanks to COUNT WARTEGG.

April 24, 1882.

SECTION OF GEOLOGY.

The President, Dr. J. S. NEWBERRY, in the chair.

Twenty-seven persons present.

The receipt of interesting letters from Dr. JULIEN, the recently elected Vice-President of the Academy, was announced by President NEWBERRY, with notes of much scientific value regarding the explorations in which he is engaged in the islands off the coast of Venezuela, particularly on Aruba. Dr. JULIEN reports there large guano deposits, and discovers proofs of a series of repeated changes of level. He is collecting in several departments of zoölogy, and will have much interesting matter to lay before the Society on his return.

Dr. JULIEN proposed the name of the Governor of the island of Buen Ayre, JOHAN F. W. GRAVENHORST, a gentlemen of scientific culture, as a Corresponding Member of the Academy, and he was at once unanimously elected.

Dr. B. N. MARTIN referred to the very remarkable display of aurora during nearly the whole night of the 16th inst., as did also the President. A brilliant corona was formed; the entire sky was covered with tremulous sheets and waves of white light; and all the telegraph wires were rendered useless for a time in New York, while the disturbance reached widely over the country and even affected the submarine cables.

The death of one of the oldest Fellows of the Academy, Mr. WM. H. LEGGETT, was announced by Dr. MARTIN, and he and the President gave outlines of the personal and scientific record of Mr. LEGGETT, of his scholarly attainments, especially in Greek, of his

great devotion to botany, and of his long interest in the Academy and its work.

The President also announced the death of the eminent Mr. CHARLES R. DARWIN, Honorary Member of the Academy, and discussed the great importance of his labors in enlarging the modes of investigation in biology.

Prof. JOHN J. STEVENSON then read the following paper:

THE MINERAL RESOURCES OF SOUTHWEST VIRGINIA.

The Virginias were surveyed by Prof. W. B. ROGERS and a competent corps of assistant geologists during the five years previous to 1841, but the final report was not published and only a few copies of the annual reports were printed. The latter are now so rare that practically the only available information respecting the geology of Virginia is that obtained by examinations made for private parties or corporations.

The region to which attention is called extends from New River to the Tennessee line, and lies between the Great Valley of Virginia at the southeast and the State line at the northwest. It is drained by the Clinch and Holston Rivers, except in the northeast, where the waters flow into New River, a tributary of the Ohio.

The surface is rugged throughout, there being nine ranges of mountains between Bristol on the Tennessee border and the Kentucky line, a distance of little more than forty-five miles. Some of these ranges are very abrupt, and water-gaps are widely separated; so that between the Tennessee line and New River, a distance of not far from 120 miles, only two really good railroad routes have been found from the Valley to the coal-field, and these are available only for narrow-gauge roads.

This ruggedness is due to upthrow faults, of which seven occur between the Valley and the coal-field, a distance of about thirty miles. The Medina, the great mountain-making rock of the Appalachian region, is brought up four times in the interval. The effect of these faults on the agricultural conditions is curious, for the area is divided into alternating poor and rich valleys; the former underlaid by the Upper Silurian or Devonian shales, while the latter show the Lower Silurian limestones. Some of these faults are stupendous, bringing the Knox sandstone into contact with the Quinnimont Group, a vertical extent of not less than 8000 feet. While these faults have led to the removal of the coal beds almost wholly from the faulted area, they have made fair amends by bringing to the surface more than once the ore-bearing

groups known as the Lower Helderberg, Clinton and Knox or Calciferous.

The existence and excellence of the iron ores of Southwest Virginia have been known for many years; but the chief interest of the region now centers in the coal deposits, whose value and accessibility have been ascertained very recently. The coal occurs at three horizons:

The Coal Measures,
The Quinnimont Group,
The New River Group.

The area of the *Coal Measures* in Virginia is comparatively small, probably less than 600 square miles, the greater part of the field being in Kentucky and West Virginia. It occupies portions of Lee, Wise, Russell and Buchanan Counties, lying along the Kentucky border. The most readily accessible part is that in Lee and Wise Counties, and is drained by Powell River, a large stream entering Clinch River near Knoxville, Tennessee. Stone Mountain, a bold ridge of vertical conglomerate and the southeastern wall of the coal-field, is broken by two gaps, through which the Powell River and its North Fork flow. These can be reached by following the river from Knoxville, or by a shorter, though more difficult, route from Bristol, on the Norfolk and Western Railroad. The latter route has been chosen, and a narrow-gauge railway is in course of construction.

Measurements on the head waters of Powell River, behind the "Big Stone Gap," afforded me a vertical section of nearly 2500 feet of Coal Measures, containing twenty-one *coal beds*, varying in thickness from four inches to fifteen feet; but the productive part of the section is confined to the lower 920 feet, the beds higher up being very thin. This section doubtless represents all the Coal Measure groups of Pennsylvania, but detailed comparisons are impossible for the present, there being no limestones or other fixed horizons to be used for that purpose.

Four of the *coal beds* deserve notice. Two beds of *splint* are found high up in the productive portion of the section. They are separated by an interval of 70 feet, and are from 3 feet 6 inches to 4 feet thick. Their coal is a hard gray splint, very like that obtained on the Kanawha. Analyses by Mr. A. S. McCreath show that this Powell River splint contains little more than 3 per cent. of ash and less than one-half of one per cent. of sulphur. The *Kelly Coal-bed*, 215 feet below the lower splint, is from 2 inches to 15 feet thick, but in a large part of the area maintains a thickness of from 5 to 7 feet. The middle bench, 2 feet 6 inches thick, is an admirable *gas coal*; the lower bench is a fair splint, while the upper bench is worthless. Mr. McCreath found in the middle bench, .890 per cent. of ash, .771 per cent. of sulphur, while the volatile matter is 38.850. The *Imboden bed* is 50 feet

below the *Kelly*, and varies in thickness from 6 feet 11 inches to 8 feet 5 inches. Its top bench is splint, about one foot thick, which gives excellent support to the roof. The rest of the bed yields an admirable coal, somewhat softer than the Pittsburgh, but harder than the Connellsville, so that it will bear shipping very well. A section of this bed yielded Mr. McCREATH: Volatile combustible matter, 35.920; Sulphur, 0.594; Ash, 1.515. This is an excellent *coking coal*, and its coke should contain not more than three or four per cent. of ash with a half per cent. of sulphur. Its excellence will be seen by comparison with Connellsville coke, which contains 9 to 13 per cent. of ash, or New River coke, with 6 to 7 per cent., or Oxmoor coke, with 5 to 6 per cent. Some of the lower beds in the section are workable, but in view of the larger beds, they are unimportant.

As this area lies beyond the faulted region, the dip is gentle. The forks of Powell River are long and flow in deep gorges, so that an enormous area can be worked without resort to artificial drainage. It is estimated that from 50,000 to 70,000 acres can be reached in this way at the head-quarters of Powell River, and that an area half as large is equally available on the North Fork of that stream.

This series is persistent in Russell and Buchanan Counties, where beds apparently answering to the *Lower Splint*, *Kelly*, and *Imboden*, have been discovered; but the character of the coal has not been tried.

The *Quinnimont Group* of Virginia and West Virginia is equivalent to the Seral or Pottsville Conglomerate of Pennsylvania. It is unimportant in Lee and Wise Counties, attains its maximum importance before New River is reached, and thence gradually decreases, until in Randolph County, of West Virginia, it again becomes unimportant. The series is 1000 feet thick on Powell River, where it has six coal beds, all very thin and without value except to supply domestic fuel. A section of about 600 feet of the lower part of the group was obtained on the Laurel Fork of Bluestone Creek, at the eastern end of Tazewell County. This shows 9 coal beds, varying in thickness from 6 inches to 11 feet. This area can be reached without much difficulty, from the Chesapeake and Ohio Railroad, or by a route following New River from the Norfolk and Western Railroad to the mouth of East River, and thence up the latter stream to its head, where, by crossing a narrow summit, the Laurel Fork is reached. A road is in course of construction along the latter route. Two of the *coal beds* merit especial attention. The *Nelson bed* shows from 5 to 9 feet of coal, the thickness being greatest on Laurel Fork, but less and less as one goes thence toward New River. The *Coal Branch bed*, 60 to 70 feet higher in the series, is from 5 to 8 feet thick, the latter on a branch of Laurel Fork. The quality of both these beds appears to

deteriorate eastward. Analyses of these coals from Laurel Fork, made by Mr. McCREATH, show the volatile matter to vary from 20 to 21 per cent.; the sulphur from 3 to 4-tenths of one per cent.; while the ash is little more than 2 per cent. For the most part, the dip of these beds is gentle, and they are available for a long distance. The coal is very soft and will not bear handling, but it can be mined very cheaply. Its coke is marvelously clean, and should be fully equal to that manufactured on New River. It should be as pure as that from the Powell River coals; but the low percentage of volatile matter will detract from its strength. At the same time, the volatile portion is greater than in the Broad Top and New River coals, both of which yield coke which bears well the burden of 60 feet stacks.

The *New River Series* belongs to the Vespertine or Pocono of Pennsylvania. The coal bearing part of this group is wanting in Scott and Lee Counties, but it develops rapidly north-eastward, where it has been studied by Lesley and Fontaine. The beds attain their greatest thickness in the south-eastern side of the area, where, alongside of the faults, small patches have escaped erosion. Some of the beds are from 5 to 8 feet thick; but, for the most part, the coal is inferior in quality and contains much ash. The volatile matter is low, and the coal is usually spoken of as anthracite or semi-anthracite; its economic value is insignificant.

The *iron ores* are brown hematite and "fossil ore" (Clinton), with here and there a little magnetite. The Lower Helderberg yields brown hematite, which fills pockets or cavities in the limestone. This ore abounds in Scott and Wise Counties, on Clinch River and its tributaries; but its quality varies annoyingly. At some localities it is very sandy, while at others it is clean enough for Bessemer treatment. Mr. McCREATH'S analyses show the variations to be: Metallic iron, 41. to 52.; Sulphur, .030 to .060; Phosphorus, .057 to .890; Insoluble matter, 7.840 to 22. The ore from some of the pockets has been smelted in open-hearth forges.

The *Clinton* ores have been brought up along five lines, most of which are unbroken from New River to beyond the Tennessee line. The importance of these ores was recognized by the Director of the third Geological Survey of Kentucky, and a corps carefully studied and reported on the series as shown along Stone Mountain for 60 miles from the Tennessee line. These ores are rather higher in metallic iron than those of the same series in Pennsylvania, and are very low in phosphorus, seldom showing more than 11 hundredths of one per cent.

The *Calciferous* ores, those of the Knox group, are exposed in a broad area. They occur in great pockets, and have been prospected extensively within the mountain area of Scott and Russell Counties,

within the last fifty years, to supply a forge in the former county. These ores are the same with the brown hematites of the Great Valley, on which all the furnaces between New River and the State line depend for supply. For the most part this ore is of excellent quality, and Mr. McCreath's analysis shows 58 per cent. of metallic iron, with only 75 thousandths of one per cent. of phosphorus, and less than 4 per cent. of insoluble matter. It is not improbable, however, that the ore may average higher in phosphorus than the sample analyzed.

Manganese occurs with these Lower Silurian ores, and sometimes it is of excellent quality. At one locality ore was obtained which has 81.45 per cent. of oxide of manganese, with but 27 thousandths of one per cent. of phosphorus.

The Tennessee marbles, belonging to the Trenton Group, must not be overlooked. These occur in the area lying behind Clinch Mountain, where the quantity is almost inconceivable. A number of samples from Estillville, in Scott County near the State line, were polished, and eight of them were regarded by dealers as belonging to the first grade.

The following paper was read by title:

"Index to the Literature of Electrolysis and its applications, 1784–80;" by W. Walter Webb, assistant in the Scientific department of Trinity College, Hartford, Conn. This paper will appear in the Annals, forming another member of the series of Indexes to the Literature of Chemistry, therein contained.

May 1, 1882.

Regular Business Meeting.

The President, Dr. J. S. Newberry, in the Chair.

The report of the Council was read, recommending the election to Resident Membership of

Rev. Edward Payson Thwing,

Rev. B. F. Da Costa.

Their election was voted unanimously.

Mr. W. LeConte Stevens exhibited and described

an improved form of organ-pipe sonometer.*

Dr. B. N. Martin read an extended notice of the life and works of the late Prof. John W. Draper.†

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* Published and illustrated in the American Journal of Science, 1882.
† Published in full in the Magazine of American History, 1882.

May 8, 1882

SECTION OF BIOLOGY.

The President, Dr. J. S. NEWBERRY, in the Chair.

Forty-three persons present.

Mr. G. F. KUNZ exhibited choice specimens of several varieties of feldspars, including "moonstone" from Ceylon, and from Chester County, Penn., "sunstone" from Chappaqua, N. Y., oligoclase from Norway, etc.

He also announced the death, on May 5, of a Corresponding Member of the society, Mr. WILLIAM S. VAUX of Philadelphia, long eminent as a mineralogist, and a leading patron of science in the city of his home. Mr. KUNZ made special reference to the extent and elegance of his celebrated collection.

The PRESIDENT spoke further of Mr. VAUX, and particularly of his active connection with the Academy of Sciences of Philadelphia, and with the American Association for the Advancement of Science.

Prof. H. L. FAIRCHILD then gave the address of the evening, largely illustrated with blackboard drawings and lantern views, on the subject of

METHODS OF ANIMAL LOCOMOTION.

(Abstract.)

Self-motion is the most prominent characteristic of life. This remarkable power of overcoming the forces of Inertia and Gravitation is not confined to animals. Many plants have, besides the capability of upward growth and extension, more or less motion of some organs. In the lowest forms of life, plants and animals can not be distinguished by their locomotive powers. Many microscopic plants move about in water as lively as animals, and propelled by similar organs. Nor can the movements be distinguished as voluntary in animals and involuntary in plants. Consciousness and will are not more evident in the lowest animals than they are in the Venus Fly-trap and the Sensitive Plant.

It is doubtless true that all animals can move from place to place at some period of their life. For example the coral polyp, oyster and barnacle possess locomotive powers only in the embryo state, becoming fixed in the adult; while in some other animals, as the jelly-fish these conditions are reversed.

The means of locomotion are exceedingly various. The lowest method is exhibited by the amoeba, in which progression is secured by

change of shape of the entire mass of the unicellular body. The power of movement here resides in the unorganized protoplasm, without any organs whatever. Even in the lowest form of life there is a conversion of *Vital* force into *Physical* force.

Higher in the animal scale we find motion by means of cilia. These are minute elastic filaments which have a whip-like motion—alternate flexion and extension. But the cilia do not seem to be controlled necessarily by the creature's will. The motion is evidently automatic. Many low plants, as well as animals, have the body covered with cilia by which they tumble about in the water very lively. In some of the infusorians, however, the cilia seem to obey the animal's will.

The means of motion in all higher animals is muscular tissue. This is a highly specialized tissue, subjected to the nervous system, and which concentrates the power of movement, which in the amoeba was diffused through the whole mass of the body. Muscular power resides in the contractility of the cells. Expansion of the cells or the extension of the whole muscle is produced by elastic reaction—a merely physical force—or by contraction of opposing muscles. Muscles act under nervous, electric or other stimulus; but sometimes no stimulus seems necessary.

The organs and methods by which the vital contractile force of muscular tissue is utilized in producing mechanical power is a most interesting study. [With the magic lantern a few of the more typical and interesting methods of locomotion in animals were shown.]

A few animals move without organs, as the sea-anemone in crawling or the jelly-fish, leech, and snake in swimming. But most animals have parts or organs specially adapted to locomotive purposes. The old classification of swimming, flying and walking will answer our purpose.

Locomotion in water requires much less effort than locomotion in the air, and more than locomotion on solids. But the organs for swimming are comparatively simple. The lobster swims backward by its tail fin, which is a combination of beautiful oars. The squid swims in any direction, by ejecting the water of respiration out of a flexible tube.

Swimmers *par excellence* are the fishes. They propel themselves chiefly by their tail fin, used as a horizontal scull oar. The remaining fins are used to guide and control the motion. The paired fins are based upon the arm and leg bones. The rays fly through the water by means of the pectoral fins and side expansions of the body. The whale propels himself by the vertical motion of the body and tail Frogs, turtles, crocodiles and many birds are especially adapted to a life in water.

Locomotion in Air.—On account of the extreme rarity of the atmo-

sphere, flight requires special apparatus and structure and very great muscular power. But insects and birds outstrip all other creatures. Their whole structure is wonderfully adapted to aerial life ; the skeleton light, the body filled with air, the wings elastic and light, but firm, and the wing muscles exceedingly powerful. Wings of birds are quite similar in principle and structure, but wings of insects greatly differ. Three classes of insect wings may be noticed : the transparent wings of the bee, fly, etc. : the dense opaque wing covers of the beetles : and the scale-covered wings of the butterfly and moth.

The wing of the bat is an expansion of skin stretched upon the long fingers and from arm to leg. Dragons passed away with the age of reptiles. The so-called flying dragon has only a parachute of expanded skin, by aid of which it can sail downward through the air. The flying squirrel has a similar apparatus. In the flying-fish, the pectoral fins are very large, and serve a similar purpose. Some spiders are able to sail the air by means of kites or sails made of their silken webs.

Locomotion on Solids.—A much greater variety of organs are used for moving on solids. The leech, star-fish and cuttlefish employ suckers, which are little cupping glasses or diminutive water-pumps. The earth-worn has minute spines, and the serpent large scales or scutes on its belly ; caterpillars have pins rather than legs. The foot of the clam is a fleshy protuberance which can be pushed into the sand, enlarged at the end and then shortened. The snail glides over the surface by sets of short muscles in the under side of its body ; flies adhere by a fluid, exuded by the hairs on the surface of their foot discs.

Of jointed limbs the millipede has, in some species, two or three hundred. The centipede has thirty or forty legs ; crabs and lobsters have ten legs, but two used as pincers. The spider has eight legs, and the true insects have six legs. The reduction in the number of similar organs indicates advance in locomotive powers.

As the skeletons of all vertebrates are built on the same general plan, the four limbs of all show a certain resemblance ; of course, the similarity is most evident in the legs of quadrupeds.

The limb bones of fishes are in nearly all cases within the body, as the basis of the paired fins. But in some fishes they are sufficiently developed to be useful for crawling. In reptiles the limbs are generally awkward on land, although some lizards are agile. The legs of birds are highly specialized.

While mostly intended for running on land, the mammals nevertheless exhibit a greater diversity of organs and methods of locomotion than any other class of animals. Here we find the swimming whale and seal, the flying bat, the sailing lemur and squirrel, the creeping

sloth, the jumping kangaroo, the swinging monkey and the swift running quadrupeds.

The arms and legs of the running mammals are highly developed, and the mechanical construction and action of the parts are beautiful and wonderful. The muscles of the body are largely grouped about the shoulders and hips.

The arms are usually straight, but in the swifter animals, as the deer and horse, the legs are considerably bent. In the elephant the legs are straight columns supporting the huge body.

The normal number of phalanges is five, but there is great variation. The hoofed quadrupeds may have three, as the rhinoceros: two, as the ruminants: or one, as the horse. Some mammals walk on the whole sole of the foot, as the bear and man, termed plantigrade; others on the toes, as the cat and dog, digitigrade; while the foot of the seal is termed pinnigrade, and the hoofed quadrupeds, ungulate.

May 15, 1882.

LECTURE EVENING.

The President, Dr. J. S. NEWBERRY, in the Chair.

The hall was filled by a large audience.

The closing lecture of the monthly course for the season was delivered by Prof. H. CARRINGTON BOLTON, Ph. D., of Trinity College, Hartford, Conn., on the subject of

GLACIERS.

The lecturer treated of the chief glacier regions, especially those of the Alps, of the various physical phenomena presented by them, of the several theories of ice motion, and of personal experiences in travelling among glaciers, illustrating the whole with a varied and striking series of photographic lantern views.

May 22, 1882.

SECTION OF GEOLOGY.

The President, Dr. J. S. NEWBERRY, in the Chair.

Twenty-two persons present.

Prof. O. P. HUBBARD, exhibited a peculiar organic salt, malate (or, perhaps, bi-malate) of lime, from Williamstown, Vt., derived from the sugar-maple. In the manufacture of the sugar,

the syrup, when ready to crystallize, is strained through a flannel filter, and this substance is thus obtained, as a fine white or buff crystalline powder. He had long known it, as obtained rarely and in small amounts at Hanover, N. H., in the mica-slate region ; while from the towns in Vermont, where the rocks are more calcareous, it is common and abundant. At Williamstown, there are springs that deposit calcareous tufa.

The substance is popularly called "sap-sand" and "sugar-nitre;" in Steele's "Fourteen Weeks in Chemistry," it is referred to as *silica!*

The PRESIDENT remarked upon the power of plants to select their food from the soil, and to form organic salts by laws and processes as yet largely unknown to us.

Various minerals were exhibited by Mr. G. F. KUNZ and Mr. W. L. CHAMBERLIN.

Capt. J. H. MORTIMER showed specimens of granite, compact and disintegrated, and of the resulting kaolin, from the Island of Jersey; also, a specimen of the red syenite, of the Egyptian obelisk set up on the banks of the Thames, similar to the one now here.

The subject of the disintegration of granites and the production of kaolin, was further remarked upon, and examples cited from various localities [Mystic, Conn., the White Mountains and New York Island], by the PRESIDENT, Prof. O. P. HUBBARD and D. S. Martin.

A paper by Mr. ISRAEL C. RUSSELL, was then read by Prof. MARTIN, entitled:

SULPHUR DEPOSITS IN UTAH AND NEVADA.

Sulphur deposits of sufficient extent to attract attention from their economic importance have been visited by the writer at three localities in the Great Basin. These are located at Cove Creek, Millard County, Utah; near Humboldt House, Humboldt County, Nevada; and at Rabbit Hole on the eastern edge of the Black Rock desert in Northwestern Nevada.

Sulphur Deposits at Cove Creek.

Of these deposits, the most interesting to the geologist are those occurring at Cove Creek in Southern Utah. This locality is on the eastern border of the Great Basin and at the western edge of the region of the high plateaus recently described by Captain DUTTON. Eastward is a

high range of trachytic mountains, that sweep around to the northwest and southeast, forming a crescent-shaped alcove in the western face of the range, the points of which are about ten miles apart. Between the horns of this crescent, and three or four miles southwest of the Ranch Fort at Cove Creek, is a conical mountain of basalt, having the ruins of a cinder cone at the summit; for convenience we shall call this old volcano the Cove Creek crater. From the perfection of its outlines, this crater seems to be of a very recent date, but is clothed with a scattered growth of cedars. Judging from its general appearance and the amount of weathering it has suffered, it is probably older than the post-Bonneville craters near Fillmore, Utah. The Cove Creek crater is now in the condition of a nearly extinct fumerole, as hot air and gases are said to escape from cracks and fissures near the summit of the mountain. The area, between the base of the crater and the mountains to the eastward of Cove Creek, is occupied by subaerial gravels, except along the immediate base of the eastern range, where volcanic tuffs appear at a number of localities. Along the line where the alluvium slopes upward to meet the tuffs and volcanic rocks, is where the majority of the sulphur mines have been opened.

Prospecting for sulphur was begun at Cove Creek, about ten years since, by Mr. C. A. SEMLER, and has been carried forward by him with much energy ever since. At the present time fifteen mines have been located, a few of which have been developed to a slight extent, and a large number of prospects opened. The mines, however, have not yet been worked sufficiently to make the sulphur from this locality an article of commerce.

From the hasty examination that I was enabled to make, I find tha the sulphur deposits at Cove Creek arrange themselves in three convenient groups, the divisions depending, however, more on the nature of the cavities that have received the sulphur, than on any difference in the manner in which it has been introduced. In one instance the sulphur occupies a nearly extinct solfatara; again we find it impregnating and cementing beds of volcanic tuff; at other times, the sides of fist sures are sheathed with a brilliant drusy lining of sulphur crystals. In all of these instances it is evident that the sulphur has been derived from deeply seated sources, having been expelled in a gaseous form and condensed and crystallized in the cavities and fissures in the cooler rocks above.

In the mine named the *Cleveland* by Mr. Semler, situated about two miles southward of the fort at Cove Creek, the sulphur occurs in quantity, filling the crater of a solfatara. The bottom of the little valley, in which the Cleveland is situated, is nearly circular, with a diameter of about 1200 feet, and is totally destitute of vegetation. Over the level

surface of the strange little desert the sulphur outcrops in many places, forming ledges of sulphur; and a number of prospects show an abundance of quite pure material. A shaft was sunk in the centre of this deposit, to the depth of twenty-five feet, all in pure sulphur, as I was informed by Mr. Semler. The material taken from this shaft has been returned to it, in order to guard against the burning of the mine, and the broken fragments are now cemented into a solid mass by the sulphur that has been deposited in the interstices between the broken masses. The deposition of sulphur is still in progress, the prospecting holes becoming lined in a few days with most beautiful plumb-like crystals of pure sulphur. The temperature in all the openings in this sulphur bed is high. At the surface of one of the prospecting holes which had been refilled with broken fragments, the thermometer read 104° F.; and through all the openings vapor and heated gases are constantly escaping. In cold weather the clouds of vapor forming above this mine may be observed from a distance of a mile or two. The drops of moisture that condense on any cold object held for a moment in the excavations, are intensely acid, and from their taste seem to a contain a large proportion of sulphuric acid. No chemical examinations of these acid drops or of the gases that are constantly escaping from the openings could be made. It is noticeable, however, that no odor of sulphuretted hydrogen can be detected about the mines; but from a few simple tests, and from the presence of dead animals in a large number of the openings, it seems evident that carbonic acid is exhaled in large quantities. The sulphur at this locality covers a circular area of about 1000 feet in diameter, and, from the prospects that have been reported, cannot be less than twenty-five feet thick. This is not pure sulphur, however, but certainly carries a large percentage of earthy matter.

The conclusion arrived at, from a hurried inspection of this interesting locality, is that the sulphur fills a nearly extinct solfatara, into which it has been conducted from below, seemingly by direct sublimation, or, what is perhaps more probable, by the decomposition of sulphurous gases, and the deposition of the liberated sulphur. A careful examination of the fumes that are exhaled from these openings would certainly be of much value in determining the chemical history of sulphur deposits.

Of the second class of mines—those in which the sulphur impregnates beds of volcanic tuff—we have examples in the *Mariposa* and *Prince Albert*, situated at the base of the mountains, two miles east of the fort at Cove Creek. At these localities the tuff is stratified, and contains scattered pebbles of quartzite and limestone, and is impregnated over a large area with sulphur, which fills all the interstices of

the rock. Judging by the eye alone, much of the tuff contains from ten to forty per cent. of sulphur, while in localities the rock is far richer than this. Overplacing the tuff are alluvial cones of gravel, that are in some places cemented by sulphur in the same manner as the strata of tuff beneath, thus showing that the beds now carrying the sulphur have acted simply as condensers for the sulphur, which in every case has been derived from a deeper source.

The third class of sulphur deposits—those in which the sulphur forms a lining of crystals on the sides of fissures—are illustrated by the *Philadelphia* and *Mammoth* mines. At the first of these, situated one mile north of Cove Creek, the sulphur occurs in drusy crystals covering the sides of small intersecting fissures in trachyte. The rock has here been much broken along a line of faulting, which may be traced southward to the top of the Cove Creek crater. The Mammoth mine is of a similar character, but found in dark carboniferous limestone. This mine is located on the top of the divide between Cove Creek and Dog Valley to the northward. While standing on this pass, the line of faulting, on which the Mammoth mine is situated, may easily be traced southward to the valley of Cove Creek ; and across the valley it is again seen as a bold fault-scarp, with a throw to the westward, ascending the side of the volcanic crater that we have already mentioned several times. The fault crosses this cone just to the east of the summit, and has given the eastern slope of the mountain a steeper inclination than is shown by the western side. Northward from the Mammoth mine the same line of faulting is continued for many miles, and shows a recent scarp all along the eastern border of Dog Valley. The fault-scarp that ascends the side of the volcanic cone, and also the recent scarp in Dog Valley, are the results of slight and very recent movements along an ancient line of profound displacement. The volcanic mountain southwest of Cove Creek has been built over this old line of fracture. The sulphur in the Mammoth mine has been deposited in the fissures made by the faulting of the strata, and in the seams and openings between the layers of limestone. The rock on the borders of these fissures, beneath the thin lining of sulphur, has been altered to a brown earthy mass, to the depth of about half an inch. The mines, like the Philadelphia and Mammoth, that have been opened on lines of fracture in solid rock, show but little sulphur, and on the whole cannot be considered as giving promise of any large deposit below the surface. In these mines also the temperature is high, but not so great as at the Cleveland.

The beds of volcanic tuff, in which the sulphur has been deposited, probably rest on harder rock that has been fissured, thus allowing the sulphur-bearing vapors to escape upwards, as in the case of

the Philadelphia mine; but no section showing the tuff beds above such fissures has been exposed. As these beds of tuff occur for many miles along the base of the mountains, we may hope that the conditions for charging them with sulphur have been many times repeated. Next to the Cleveland mine, we should certainly look to the beds of tuff, along the base of the mountains eastward of Cove Creek, for the principal supply of sulphur for economic purposes from this region.

Owing to the exhalation of noxious gases in nearly all the prospects that have been opened, we find in the bottoms of the excavations large numbers of dead insects, together with the remains of mice, bats, rabbits, etc., that have been smothered by the escaping gases. In many of the openings a choking sensation is felt, and the amount of gas, which seems to be largely carbonic acid, is so great that a person can remain in them but a few seconds. Even in shallow prospects the workmen have to fan each other, in order to remain in the openings long enough to do their work. These mines can only be opened from the surface, and even by this method they cannot be worked to any considerable depth, owing to the high temperature of some of the prospects and the constant escape of noxious gases.

Associated with the deposits of sulphur are beds of gypsum, and also irregular deposits of "alum." Just what the nature of this "alum" may be has not been determined by analysis. These beds usually overlie the sulphur deposits, the alum being sometimes two feet thick, and the gypsum as much as eight feet. Hot springs occur in the same field, which, together with the feeble fumerole at the top of the old crater, bear evidence of the expiring volcanic energy of the region.

Sulphur Deposits at Humboldt House, Nevada.

The sulphur at this locality has been reported as occurring in nearly vertical fissures that are associated with recent basaltic buttes. Careful search was made by the writer, however, for fissures answering these conditions, while examining the surface geology of the Humboldt Valley, without successful results. The only sulphur deposits that could be found in the vicinity, and the only ones known to the people living at Humboldt House, occur in the craters of extinct hot springs. These craters are situated about half a mile southward of Humboldt House, on the open sage-brush desert, and rise to the height of from twenty to fifty feet, as nearly as could be estimated. Nearly all of the cones are weathered and broken down, and all are extinct, the water now rising to the surface for miles around. The outer surface of the cones is composed of calcareous tufa and silicious sinter, forming irregular imbricated sheets that slope away at a low angle from the orifice at the top. The interiors of these structures are filled with crystalline gypsum, that

in at least two instances is impregnated with sulphur. One of the cones has been opened by a cut from the side in such a manner as to expose a good section of the material filling the interior, and a few tons of the sulphur and gypsum removed. The percentage of sulphur is small, and the economic importance of the deposit, as shown by the excavation already made, will not warrant the further expenditure of capital. The cone that has been opened is surrounded on all sides by a large deposit of calcareous and silicious material, thus forming a low dome or crater, with a base many times as great in diameter as the height of the deposit.

These cones correspond in all their essential features with the structures that surround hot springs that are still active in various parts of the Great Basin, thus leaving no question as to their origin. They are situated within the basin of Lake Lahontan, and must have been formed and become extinct since the old lake evaporated away.

Sulphur is reported as occurring in the chemically formed deposits that surround Steamboat Springs, situated midway between Carson and Reno, Nevada. The conditions at these springs must be very similar to what existed near Humboldt House, at the time the cones containing the sulphur were formed.

Sulphur is also said to occur in the Sweetwater Mountains, situated on the boundary between California and Nevada, in latitude 38° 30′; the extent and geological relations of these deposits are unknown.

The Rabbit Hole Sulphur Mines.

These mines are located in northwestern Nevada, on the eastern border of the Black Rock Desert, and derive their name from the Rabbit Hole Springs, a few miles to the southward. The hills bordering the Black Rock Desert on the east are mainly of rhyolite, with a narrow band of volcanic tuff along the immediate edge of the desert. These beds of tuff are stratified and evidently water-laid, and are identical with tuff deposits that occur over an immense area in Oregon and Nevada. At the sulphur mines, the tuffs contain angular fragments of volcanic rock and are cemented by opal and other silicious infiltrations since their deposition, so that they now form brittle silicious rocks with pebbles and fragments of older rocks scattered through the mass. In many places these porous tuffs and breccias are richly charged with sulphur, which fills all the interstices of the rock and sometimes lines large cavities with layers of crystals five or six feet in thickness. In the Rabbit Hole district, sulphur has been found in paying quantities for a distance of several miles along the border of the desert, but the distribution is irregular and uncertain, and is always superficial, so far as can be judged by the present openings. As in the Cove Creek mines, the sulphur at

Rabbit Hole has been derived from a deeply-seated source, and deposited from a vaporous condition, in the cooler and higher rocks in which it is now found. Judging from the silicious material that cements the tuffs, it is evident that the porous rocks, in which the sulphur is now found, were penetrated by heated waters bearing silica in solution, previous to the deposition of the sulphur. These mines occur in a narrow north and south belt, along a line of ancient faulting which is one of the great structural features of the region. The association of faults, with sulphur bearing strata of tuff, is here essentially the same as at the Cove Creek mines. At the Rabbit Hole mines, however, no very recent movement of the ancient fault could be determined. This absence of a recent fault-scarp, together with the fact that the mines are now cold and do not give off exhalations of gas or vapor, shows that the solfataric action at this locality has long been extinct.

At all the localities visited, the sulphur has been derived from sources far beneath the surface, from which it has been expelled by heat, and escaped upwards through fissures that were formed along lines of faulting, and has been condensed on the sides of fissures and in the interspaces of the cooler rocks near the surface. Whether the deposition of the sulphur took place by direct sublimation, or by the decomposition of sulphuretted hydrogen, has not been determined. The date at which the sulphur was introduced into the rocks, where we now find it, is in all cases very recent, and at the Cove Creek mines the action is still in progress.

Work at the Rabbit Hole mines is now being carried forward by a day-shift of seventeen men, the production of sulphur being about six tons per day. The value of the sulphur produced is about forty-five dollars per ton in San Francisco. The sulphur, after being mined and assorted, is placed in upright cast-iron retorts, having a general resemblance to the common form of blast furnace, with a capacity of about two and one-half tons. When the retorts are charged, the opening at the top, through which the sulphur bearing rock is introduced, is closed, and superheated steam admitted at the side. The steam pressure is at first about seventy pounds to the square inch ; but, as the sulphur begins to melt, the pressure is allowed to subside to sixty or perhaps fifty pounds. When the sulphur melts, it passes through a grate and is collected in a kettle beneath the retort, from which it is allowed to flow, in a very liquid brown stream, into a receiving pan with a capacity of about twelve thousand pounds, where impurities that were previously held in suspension are allowed to settle to the bottom. From the receiving pan, the sulphur is run into molds shaped like the frustum of a cone, each of which has a capacity of from two hundred to two hundred and fifty pounds. When allowed to stand a few days after cool-

ing, these cylindrical masses break into irregular lumps, in which condition the sulphur is delivered to the refinery at San Francisco.

DISCUSSION.

The PRESIDENT remarked at some length upon Mr. RUSSELL'S paper, giving extended observations of his own in the volcanic rocks of that region.

Remarks were made by several members, and by the PRESIDENT, upon the recent "Forestry Congress," and the great importance of the subjects discussed by that body.

May 29, 1882.

SECTION OF PHYSICS.

The Vice-President, Dr. B. N. MARTIN, in the Chair.

Fifty-seven persons present.

The Secretary exhibited a fresh specimen of the common squid (*Ommastrephes*, sp.), and remarked on the habits, affinities, and geological relations of these animals, and also on the accounts, given by Prof. A. E. VERRILL, of the recent capture of a gigantic specimen on the coast of Newfoundland. Prof. VERRILL reports the length of this individual as nine feet for the body and thirty-five feet for the entire extent, to the ends of the long "arms."

He also referred in the same connection to a story told in a work called "Ocean Wonders" (Appleton & Co., N. Y., 1879), wherein it is asserted that the author, while at Bermuda, had seen an Octopus leave the water and climb a cliff 200 feet high, in pursuit of a red crab (!). This absurd story, so impossible in view of the habits, organization and locomotive apparatus of the cephalopods, is most fully disposed of by a Bermuda naturalist, Mr. J. MATTHEW JONES, as follows:

1. There is no cliff of any kind in Bermuda that is 200 feet high.
2. There is no crab on the Bermuda shores, having a red carapace, during life.
3. The only species of Octopus known at Bermuda never leaves the water.

A paper, by Mr. GEO. N. LAWRENCE, was read by title as follows:

DESCRIPTION OF TWO NEW SPECIES OF BIRDS OF THE FAMILIES COLUMBIDÆ AND FORMICARIDÆ.

This paper appears in the Annals, Vol II., No. 11.

Dr. ELSBERG nominated as a Corresponding Member the lecturer for April last, Chevalier ERNST VON HESSE-WARTTEGG, who was thereupon elected unanimously.

Mr. ROMYN HITCHCOCK then read the following paper, illustrated with a large number of experiments :

RECENT ADVANCES IN PHOTOGRAPHY.

Perhaps it is well to introduce the subject before the Academy in a practical rather than a theoretical form, since photography is a branch of scientific study to which our men of science generally have given but little attention. Yet it possesses great interest for the chemist, who has yet to determine the decompositions which an actinic ray produces in compounds sensitive to light. It affords the student of molecular physics a wide field for investigation. A more profound knowledge of the action of light upon the photographic film will doubtless lead to a deeper insight into the nature of the actinic force itself. Already the photographic plate has enabled us to study the solar spectrum far beyond its visible limits at either end ; for not only has it enabled us to record and establish the exact position of the Fraunhofer lines beyond the violet, but, more recently, the spectrum of the red and ultra red has also been portrayed by an ingenious application of well-known facts.

There are three compounds of silver which may be used in the preparation of dry plates, the chloride, the iodide and the bromide. These compounds, being insoluble in water, can be formed by adding a corresponding salt of an alkali to a solution of silver nitrate. They are then precipitated in very minute particles. In each of these three test tubes I place a few drops of a solution of nitrate of silver. To the first one I add a chloride, which gives me a pure white precipitate of chloride of silver. To the second I add a bromide, to the third iodide. The silver bromide is yellow, the iodide is slightly so.

A brief exposure to the light of day changes the color of these salts, and it is this peculiarity which makes them valuable for photography. Years ago, when photography was in its infancy, the problem was to obtain these compounds in a sufficiently sensitive condition to be useful. If we could collect the fine particles, which are suspended in the water in those tubes, before the light has affected them, spread them in a perfectly uniform layer over a sheet of paper or upon a glass plate, and then allow an image to fall upon it in the camera, wherever the light strikes it the color would be changed, and thus a perfect photograph of

the object would be produced. But such a photograph would fade if brought out into the light; besides, it would not be very intense. It is necessary, therefore, to devise some method by which the change produced by the light can be strengthened, and then fixed. In practice, the sensitive compound is obtained upon a glass plate in one of two ways; either by coating the plate with a film of some substance that is permeable to fluids, such as collodion containing a bromide or an iodide, and then dipping the plate thus coated into a bath of silver nitrate, whereby the silver bromide or iodide is formed within the pores of the collodion; or else by precipitating the silver compound in a solution of collodion, gelatin or other medium, in such a manner that the particles will be held in suspension in a state of minute division. By the latter process a so-called emulsion is formed, which is poured over a plate and allowed to dry before use. The causes which affect the sensitiveness of the bromide are still very obscure. It is probable that this is controlled by the physical conditions under which it is formed; in other words, the size of the particles of bromide in the emulsion. The smaller the particles, the more sensitive they are. Yet it seems possible to increase the sensitiveness of an emulsion, by causing the minute particles to become mechanically aggregated into larger masses. At least, this is the explanation suggested by the able experimentalist, Captain Abney, to account for the greater sensitiveness of a gelatin emulsion after boiling. This aggregation of the particles cannot in any wise affect the sensitiveness of the constituent molecules; but, if we can understand how it causes the film to be more sensitive, we will gain an insight into a molecular change which may be said to lie as the foundation of the process of strengthening the image, which is the process commonly known as development.

It has been stated that a perfectly uniform layer of the sensitive silver salt upon a plate would show an image after exposure in the camera. This image results from the decomposition of the sensitive salt into a sub-bromide, sub-iodide or sub-chloride, as the case may be, the bromine, iodine or chlorine being set free; thus $2\ (Ag\ Br) = Ag_2Br + Br$. The change of color, resulting from a short exposure in the camera, is not great; but it is possible to so prepare a plate that the chemical change produced by light in a fractional part of a second suffices to produce an image. Under such circumstances the chemical change must be very superficial, and the decomposition too slight for the eye to detect. Hence, after a plate is properly exposed in the camera, no image is visible upon it. To make the image visible, it must be strengthened or developed.

Before describing the process of development, I will illustrate the process of making an emulsion of silver bromide for the dry-plate pro-

cess. Since the only essential part of this process is the suspension of minute particles of bromide of silver in a suitable fluid, which will dry and form a film upon a plate, we might precipitate the bromide as we did a few moments ago, only in a dark room, and rub it up in a mortar with a solution of gelatin or gum arabic, until a fine, milk-like emulsion is formed. A better method, however, and the one usually followed, I propose to carry out before you now. But first I must explain, that, unless the silver salt can be protected from the action of light, the process must be carried on in a room lighted only by a red light. Without spending any time to explain the reason, I will simply state that potassic bichromate prevents the action of light upon the silver salt, and it is therefore possible to prepare an emulsion in daylight, if this compound is used. After the emulsion is made, the bichromate can be removed by washing in a dark room, when the mixture becomes sensitive to light. I now wish to prepare a gelatin emulsion of silver bromide containing some iodide. [Emulsion prepared.]

After the plate has been exposed in the camera, the image is developed by any one of several methods; but all of them depend upon the fact that, in the presence of what chemists designate as reducing agents —substances which greedily absorb oxygen—a salt of silver is decomposed with the deposition of metallic silver. When such a reducing agent is caused to flow over the plate, the reducing action is most powerful at those places where the light has acted upon the sensitive silver salt and decomposed it. Therefore at such points metallic silver is deposited in very minute, black particles, and, as these increase in quantity, the image becomes visible, acquires density, and details are faithfully brought out.

We can readily illustrate the action of the developer by an experiment. Here is a quantity of silver bromide, which has been precipitated and exposed to sunlight. I have here another precipitate of the same compound, which has been protected from the light. To each of these I will add a developing solution, and you will see the rapidity with which the silver is reduced in one case, and how much more slowly it changes in the other. [Experiment made.] Precisely the same effect is produced in developing the invisible image on the exposed plate. I will now develop a plate which was exposed in my camera, one week ago to-day. It is a stereoscopic view of a modern windmill, which is to be found just above High Bridge. The developer to be used is a mixture of ferrous sulphate, or green vitriol, as it is called, with potassic oxalate, containing some potassium bromide. By mixing the two solutions first mentioned, a solution of ferrous oxalate is obtained, which is the active agent in effecting the reduction, the bromide of potassium being a restrainer—preventing the too rapid and too gen-

eral reduction of the silver salt. Those who are familiar with photographic process will keep in mind the fact that in developing dry plates, all the silver salt is in the film, while, in the wet plate process, it is customary to mix some silver nitrate with the developer and flood the plate with it. In the case of dry plates the fingers are not soiled during this process, while with wet plates they are sure to be blackened by the silver. [Plate developed.]

The time is so limited that I cannot discuss and explain the chemical process of developing a picture as fully as I would wish. I am quite sure that if we were to spend the entire evening in considering this single operation, there would be no lack of interest on the part of this audience. In studying the process of development, explaining how the invisible image is intensified and brought out in all its details, we are dealing with chemical changes which are so slight as to almost baffle our efforts to detect them. The light acts upon the molecules of the the silver salt in the plate, perhaps only the $\frac{1}{1500000}$ part of a second of time; but that is enough to overcome, or in some way to weaken, the force which binds together the constituent atoms. When the developing solution is applied, each particle of silver salt that has been thus changed, acts, we may say, as a nucleus to start the action of the developer. The tendency of the latter, as already stated, is to reduce any silver salt that may be present; but if a soluble bromide, such as potassium bromide, be present in sufficient quantity, this tendency is restrained, and no reduction will take place, unless the action is started by the partially decomposed silver salt. The balance of the chemical forces is so perfect in a well-made developer, that wherever there is a molecule of silver bromide on the plate which the light has affected, there decomposition takes place and black metallic silver is deposited, while all the rest of the plate remains white. Thus every line and every shadow and half-tint in an object is faithfully reproduced in the photograph.

After development there remains upon the plate a quantity of unchanged bromide of silver, which must be removed or the light would act upon it, and destroy the picture. The picture must, therefore, be fixed by dissolving the unchanged silver salt in sodic hyposulphite. [Plate fixed.]

In the short account that has been given of the preparation and development of dry plates, no allusion has been made to many questions of great theoretical interest, which I hope to make the subject of a future article. It has seemed best to confine this article to the strictly practical part of the subject; and I now wish to speak more particularly of the advantages of the dry-plate process, not for the photographer in business, but for the traveller and explorer, the naturalist and the student in various branches of science.

The great advantage of the process for all these purposes is to be found in the sensitive plates. They can be purchased ready for use in the camera, and will remain good for any length of time. They may be carried across the continent, exposed in a camera on the top of a mountain hundreds of miles from civilization, or in the interior of an unexplored country, then packed away in light, tight boxes, and the pictures developed months afterward in this city. In this way the geological and topographical features of a country may be accurately reproduced on paper, or, by means of glass positives, thrown upon a screen for the illustration of a lecture. The botanist may photograph a rare plant in bloom in distant lands, and the traveller in Central Africa, for instance, may portray the features of the natives he finds, with far more truthfulness than with pencil and brush.

In the laboratory, the student of physics will find many uses for photography. Already, it has been applied to the study of spectra, with great advantage, and lately the electric spark has been photographed, with an exposure, it is said, of only $\frac{1}{140000}$ of a second.

[The method of making instantaneous pictures was then described, and the apparatus was exhibited. After the Academy adjourned, the process of making positives on glass for use in a lantern was illustrated by placing a negative over a sensitized plate in a deep printing-frame, and exposing it to the light of an argand lamp for about ten seconds, after which the picture was developed and fixed in the usual way.]

June 5, 1882.

REGULAR BUSINESS MEETING.

The President, Dr. J. S. NEWBERRY, in the Chair.

Forty-five persons present.

The report of the Council was read, recommending

1. The election of the following persons, previously nominated as Resident Members:

J. K. FUNK,	W. H. MEAD,
HOWARD WAINWRIGHT,	ALEXANDER WARNER.

2. That when the Academy adjourns, it shall be to October 2.

The four persons named were unanimously elected, and the recommendation for the usual summer adjournment was agreed to.

The PRESIDENT showed teeth of *Carcharodon*, measuring five inches by six, from the tertiary "Phosphate beds" of South Carolina. This is about the maximum size ever known for fossil shark-

teeth. The modern "white shark" is some five feet long and if the proportion was the same between the size of the teeth and the whole body in the ancient *Carcharodon*, its size must have been fully fifty feet. It is noteworthy that very large teeth of similar character, but in quite a fresh condition, were dredged up in the depths of the Pacific by the "Challenger" party; which fact would indicate that this species, or one closely akin to it, had survived in the deep waters, at least until quite recently.

He also exhibited an ingot of aluminium, two inches by six, obtained by a new process, at much lower rates than had heretofore been possible, and remarked upon the many important uses for aluminium, if its cost could be reduced.

The following papers, by Mr. THOMAS BLAND, were read by title:

I. DESCRIPTION OF TWO NEW SPECIES OF ZONITES FROM TENNESSEE.

II. NOTES ON THE DISTRIBUTION OF GENERA OF TERRESTRIAL MOLLUSKS IN THE WEST INDIES.

Dr. WESLEY MILLER read a paper entitled:

THE PREVENTION OF TUBERCULAR DISEASE IN MEN AND ANIMALS BY VACCINATION.

He discussed the general theory of inoculation and vaccination, and referred to experiments made by himself, and to be further carried on, as to the reduction of virulence attainable by artificial propagation of virus through many generations, in the bodies of domestic animals.

Dr. N. L. BRITTON read the following paper:

ON SOME LARGE POT-HOLES, NEAR WILLIAMSBRIDGE, N. Y.

The "pot-holes" which I shall attempt to describe were first brought to my notice by the late Prof. A. WOOD. They are located on the western bank of the Bronx River, about midway between Bronxdale and Williamsbridge, Westchester County, New York. They are near the western end of a now dismantled and impassable bridge, with stone abutments, and in the northern part of a hemlock grove which fringes the stream for about a mile below. It is one of the most picturesque spots in the vicinity of New York City, and a walk along the little river from Bronxdale to Williamsbridge is always enjoyable.

The Bronx "River," as it is called, though the term gives it an importance which it does not possess, is a stream about 40 to 50 feet

wide, rising in Westchester County, and discharging its waters into Long Island Sound, nearly opposite College Point.

It occupies, however, the bottom of a valley, which, at Williamsbridge, must be at least half a mile wide, probably more, and two hundred feet deep below the summits of the hills which bound it to the east and west. This great depression extends northwardly with the river, but I have not studied it any further north than White Plains, where it is quite broad. At a point about three-fourths of a mile below the Williamsbridge station of the Harlem Railroad, this valley is somewhat narrowed, and much interrupted by a ridge of rock running parallel with the present course of the stream, viz., very nearly north and south. The Bronx flows through a narrow gorge cut out of this rock. It is near the northern end of this ridge where the pot-holes under consideration are situated. Leaving the train at Williamsbridge, and ascending the stream, we pass through a stretch of swampy ground of considerable botanical interest, it being the only known habitat about New York for *Arisæma Dracontium*, the "green dragon," we pass the old bridge before mentioned, and enter the grove of hemlock. The first pot-hole to be observed is quite imperfect, only a portion of the western side now remaining, the rest having been broken away. It bears S. 50° W. from the western end of the bridge, at a distance of 76 feet. The bottom of the pot is about 18 feet above the present level of the Bronx at this point, but this is less than the natural height would be, as the water is backed up by a dam half a mile below. Measurements indicate that the total depth of the hole must have been about nine feet, and at half its height the diameter not less than ten feet. This must, however, have very rapidly decreased towards the bottom.

Proceeding 136 feet south from the bridge, and then up the rocks to a point 63 feet from the river bank, the second pot will be found. This is much more perfect, and is quite a noticeable object. The bottom of this one is twenty or twenty-two feet above the present water level. The hole is oval in section, about four-fifths of the original outline still remaining, only the outer (the eastern) end being broken away. Its dimensions are as follows:

Total indicated depth, 10 feet.

Depth of nearly perfect lower part, 4′ 6″.

Depth of entire basin at the bottom, 10″.

Shortest diameter, 5′.

Original longer diameter probably about 6′.

Distance from back to broken face, 4′ 7″.

The lower part of this pot is very well preserved; the bottom and sides are very highly smoothed, indeed quite polished. The upper por-

tion, where the wear began, is now represented only by a portion of the rock surface about 5′ high and 2′ long, which is concave and smooth.

Some fifty feet southwest of this hole, and fifteen feet above it, there are two other vertical pieces of rock with smoothed and somewhat concave surfaces, which, perhaps, may be remains of others, but they are too imperfect to warrant any description.

The rock, in which these pot-holes are situated, is a compact fine-grained gneiss, with black mica. It is very much broken up by horizontal and vertical cleavage planes. There are not very many loose blocks, however, these having been carried away to the south by the glacier of the ice period. The natural strike of the strata in the vicinity is S. about 18° W. The dip is nearly vertical, being in the neighborhood of 85° N. W.

The history of the formation of these holes may be briefly outlined as follows: that, in pre-glacial times, the valley through which the Bronx now flows was occupied by a large stream, which was expanded into a broad and deep comparatively slow-moving body of water, above the point where the holes are now situated; but, at and below this point, it became a rapid, turbulent and shallow river, whose level, as shown by the position of the holes, must have been at least thirty feet above that of the present one; that the holes were produced, as they have been shown to be in other localities, by the grinding action of some harder stone on the gneiss rock, this stone being kept in a whirling motion by an eddy in the current. During the ice period the valley was deepened, and the narrow gorge, through which the waters of the Bronx now pass from below Williamsbridge to Bronxdale, was excavated, the ice sheet having carried the debris southwardly and deposited it on the terminal moraine running through Long Island. I am informed by Prof. J. D. HYATT that there are two other pot-holes, rather imperfectly preserved, near the village of West Farms, about two miles south of those described, in the same valley.

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ERRATA.

Page 3, 11th line from top, for Asaphas, *read* Asaphus.
" 8, 9th and 11th lines from bottom: for Stylomurus, *read* Stylonurus.
" 50, 14th line from bottom: for graduation, *read* gradation.
" 85, 6th " " " for Palorthis, *read* Polorthus.
" 92, 2d line from top: for Prozopis, *read* Prosopis.
" 92, 6th " " " for monolifera, *read* monilifera.
" 92, 12th " " " for Tonquieria, *read* Fouquieria.
" 92, 18th " " bottom: for Scutillaria, *read* Scutellaria.
" 92, 17th " " " for Cardioz permum, *read* Cardiospermum.
" 93, 6th line from top: for vaccata, *read* baccata.
" 93, 21st " " bottom: for Texamum, *read* Texanum.
" 94, 18th " " " for Gryphea, *read* Gryphæa.
" 104, 5th " " " for fortris, *read* fortis.
" 151, 14th " " top: for caniformis, *read* canifrons.
" 151, 15th " " " for grivigula *read* griseigula.

TRANSACTIONS

OF THE

NEW YORK ACADEMY OF SCIENCES.

October 2, 1882.

REGULAR BUSINESS MEETING.

The President, Dr. J. S. NEWBERRY, in the Chair.

Thirty-three persons present.

A paper was read by Prof. ROBERT H. THURSTON, entitled:

NOTE IN REFERENCE TO A NEWLY-DISCOVERED ABSOLUTE LIMIT TO ECONOMICAL EXPANSION IN STEAM ENGINES.

(Published in the Annals.)

The paper was discussed by Prof. W. P. TROWBRIDGE.

The following paper, by Mr. GEO. N. LAWRENCE, was then read by title:

CHARACTERS OF A NEW SPECIES OF BIRD OF THE FAMILY CYPSELIDÆ.

In accordance with the usual custom at the first meeting of the season, observations and notes made during the past summer were presented.

The PRESIDENT referred to various papers of interest before the recent meeting of the American Association for the Advancement of Science at Montreal, by Drs. RAE, CARPENTER, and others; to the collection of the Geological Survey of Canada at Ottawa, including its full series of specimens of *Eozoön*; and especially to the remarkable series of Devonian fossil fishes from the North side of the St. Lawrence, collected and described by Mr. WHITEAVES. Of these a large number of specimens were collected from two localities. They resemble those described by HUGH MILLER, being almost precise counterparts of the Devonian fishes of Scotland. Most American deposits of the kind were derived from the sediments of the open sea, but these must have come from a bay.

Dr. NEWBERRY had also visited the Saguenay, which occupies a fiord like those which fringe the coast toward the north and along the coast of Northern Europe. It consists of a valley cut deep into the old coast, now forming, in its submerged position, a tideway for a distance of a hundred miles, with tides sometimes reaching a height of eighteen

feet. At its upper end the valley is supplied by only two or three insignificant streams. It is, in fact, a glacial channel, bearing on its sides abundant marks of glaciation, with cliffs towering up, sometimes to a height of 2000 feet. There are also deposits of clays belonging to the category of the Champlain clays, stratified and often terraced. Clays of this age have been observed, at Polaris Bay, up to a height of 1800 feet above the sea, often enclosing Arctic shells. These terraces may be traced for miles along the Saguenay and indicate interesting alternations of level. Similar terraces are found along the Hudson River. The subsidence during which they were produced affected the whole eastern and, perhaps, western part of the Continent. These clays are only the wash from the ancient glaciers, and formed the sediment of an icy-cold sea, which stood higher than it does now. The subject of the causes of glaciation had met with a spirited discussion at the recent meeting at Montreal, especially on the part of Dr. DAWSON, whose views, largely founded on the peculiar action of shore-ice in the St. Lawrence, would meet with wide modification by a visit to other portions of the glaciated area of the Continent.

Prof. A. R. LEEDS called attention to the recent death of a very illustrious member of the Academy, Prof. FRIEDRICH WÖHLER, whose life, linked with the progress of science for three-quarters of a century marked an epoch in its history. He was born in 1800, and, without awaiting a further advance in his years, a great Jubilee was arranged and carried out, in connection with his eightieth birthday, among the chemists of the German Universities; and in this many American chemists united. A large bronze medal was struck off for distribution in commemoration of this event. He was one of the favorite pupils of BERZELIUS, and has given an interesting account of his studies with that master, at that time a mere country doctor, in the kitchen of his house and on the kitchen tables, the simple articles used being washed up by the old "hausfrau" at the end of the day. We owe to him the discovery of the true constitution of many mineral compounds. Many American students gradually resorted to his laboratory and to them he became the favorite teacher. Prof. BOOTH was the first American chemist to go abroad and was the first American student under WÖHLER'S care. It is a wonderful fact that the life of this one man should have been sufficient to include most of the important discoveries of modern chemical science. He was the first to unlock the mysteries of organic compounds, by his classic investigation into the constitution of urea, showing that this was made up of inorganic constituents. His life, in fact, links the modern discoveries in organic chemistry with the glorious achievements of the first quarter of the present century.

October 9, 1882.

SECTION OF GEOLOGY.

The President, Dr. J. S. NEWBERRY, in the Chair.

Forty-five persons present.

The following specimens were exhibited; by Mr. W. L. CHAMBERLIN, apatite from Renfrew, Canada, and crystals of emerald enclosing crystals of red rutile, from Hiddenite mine, N. C.; by Mr. G. F. KUNZ, "star mica" from St. Lawrence County, N. Y., and a crystal of zircon, weighing twenty-eight Troy ounces, from Sebastopol, Renfrew County, Ontario, Canada; by the PRESIDENT, a cast of a trilobite (*Asaphas gigas*), from Illinois, which clearly exhibited the legs, and is remarkable as being the first specimen in which any locomotive organs have been discovered; and by Mr. DOUGLASS, a beautifully carved pipe from San Salvador, found fourteen feet below the surface, in old Indian workings, and which is regarded as antedating the Spanish invasion.

A paper was read by Mr. F. COPE WHITEHOUSE, largely illustrated by magic lantern views, entitled:

THE CAVES OF THE ISLAND OF STAFFA: ARE THEY NOT ARTIFICIAL?

(This is embodied in a paper in the *Popular Science Monthly*, December, 1882.)

DISCUSSION.

Prof. E. H. DAY remarked on the great interest of the subject, and at the same time on the large amount of caution required in the investigation and acceptance of such views. Nature, having been the undoubted author of so many caves, can very well afford to man the credit of having made one here or there, and these perhaps amongst them. But to establish this claim we need, either direct proofs of man's handiwork, which, if beyond dispute, would be conclusive evidence; or else proof that geological action could not have produced such results, a proposition that it would be impossible to solve beyond greater or less probability. In the first line of proof, Prof. DAY had heard scarcely a word of direct evidence that would stand scientific test, and in the second, he thought that the author had ignored some of the most important geological factors.

Perhaps the strongest geological evidence, in favor of the artificial origin of the caves in Staffa, was the fact that at the Giant's Causeway, in similarly formed basaltic and columnar rocks, there are no caves, although the coast there is exposed to the full force of the At-

lantic seas; whilst in the neighboring chalk cliffs there are several deep caves. Prof. DAY described one of these caves which can be descended into at the landward end. (Mr. WHITEHOUSE here exhibited to the audience a view of this cave, which he said was "the very one that first suggested to him, that the caves of Staffa, as well as these, were artificial.") In continuation, Prof. DAY stated that Mr. WHITEHOUSE laid great stress on the necessity of very heavy waves to produce such caves. He reminded him that water charged with gravel and sand was the real agent of erosion, and that water so charged, even if only gently moved, could in the course of time produce great destruction. Moreover, waves of very limited size have very great destructive powers, as evidenced in the displacement of the granite blocks, that form the turtleback built to protect Execution Lighthouse in the Sound. Nor is there any proof, that the speaker knew of, that heavy ocean waves do bore caves into cliffs in the direction of their impact. The very violence and evenness of their attack is opposed to such a result. If one section of a cliff is weaker or more exposed than the rest, a bay will be formed; and a projecting headland between two such bays may be eaten through from each side, not by the direct attack of the heavy breakers, but rather by the incessant swirl of the waters, as they eddy around in the bays at its base. In such case, first a cave, then a high arch, and finally a chasm would be formed, but transversely to, not in the line of attack of, the ocean waves. Such arches, and the isolated pinnacles which are the final results, are common features on every rock-bound coast.

Moisture laden with sea-salts was a powerful though slow agent of erosion, very effective, as the speaker had seen, alike on churches on the south coast of England, built of perishable marlstone, and on the granite cliffs of Cornwall. To assume, as the author did, that frost had played no part in the formation of these caves, because there was at the present day no frost to speak of in that locality, and to argue that the sea could not at its present level have its share in the work, is to assume that there have been no changes of level in the coast of Scotland, and no changes of climate, since the commencement of the formation of these caves—a proposition that begs the whole question of the date of their origin.

Again, the author had totally ignored the action of water percolating through rocks, as another assistant in the work of erosion. That water did percolate through these rocks was evident from the mention made of stalactites in these caves; and, in some of the pictures shown, it certainly appeared as if the caves had been formed along lines of fissure. (Mr. WHITEHOUSE stated positively, however, that there were no fissures.) In all limestone cliffs we may expect to find caves which had

been underground water-courses, when the land stood at a different level; and the very form and arrangement of the cave, just now alluded to, in the chalk, near the Giant's Causeway, as being of artificial origin, showed that it was nothing but an ordinary limestone cave, which had been laid open by the encroachment of the ocean, and subsequently modified by atmospheric and aqueous agencies.

The argument, that the three caves described, on Staffa, were placed by design directly opposite Iona, would have more force if there were not other caves on the island not so situated; nor could great stress be laid on the approximate similarity of the measurements in case of two of the caves.

In conclusion, it seemed futile to argue that the action of the sea and of running water and of the atmosphere, as we find them at Staffa now, were unable to have excavated these caves in times past. Much less was it safe to drag in chalk caves as evidence of the artificial character of caves in basalt. The only argument of any weight in support of the whole theory seemed to be the general statement that caves such as these are not ordinarily met with in rocks at all resembling in character those of Staffa.

Mr. KUNZ enquired as to the depth of water and form of the terminal slopes in the caves.

Mr. WHITEHOUSE replied that there were no appearances of change of level at Staffa, and that the force of the waves did not reach the upper part of the caves. The depth of water in the Clamshell Cave was nine feet at the inner end, and the cave there terminated in an irregular steep slope. In recapitulation of the principal arguments:

1. There is no probability that five caves in a thousand yards would be formed by five different causes.

2. If a trap dyke formed Fingal's cave, it is geologically impossible that there was any "fault" in Boat, Cormorant's or Clam Shell.

3. There is no "*fissure*" above Cormorant's cave. The triangular opening in its columnar basalt corresponds to that in the confused basalt above Fingal's.

4. Confused basalt could not crack in a long straight fissure.

5. Tuff, underlying columnar basalt, makes a rocky shore surmounted by a steep slope of basalt. The basalt is practically solid—forms a "pier" not a "hay."

6. Why was the debris removed to an unknown distance?

7. Why did the momentum of the waves limit itself without apparent cause, and leave thin walls of tuff or basalt?

The PRESIDENT stated the impossibility of deciding such a question without a visit to the locality. He had seen many coasts undergoing erosion, but never any excavated like this, merely by the force of the

waves. If in fact no dykes nor fissures existed, such tunnel-like chambers could hardly have been perforated by natural causes, for they are on various sides of the island, in various kinds of rocks, and the debris is entirely cleared away. If the caves had been produced by causes now in action, the fallen blocks would remain. The material of the blocks is tough and not liable to disintegration; nevertheless it has been thoroughly cleared out, as though by the hand of man; no shingle being found on the shore. It is important to notice that the approaches to the caves are over low, flat ground, furrowed by canals leading up to their entrances, *i. e.*, as if artificially excavated for the entrance.

October 16, 1882.

SECTION OF GEOLOGY.

The President, Dr. J. S. NEWBERRY, in the Chair.

Twenty-four persons present.

A paper was read by Dr. ALEXIS A. JULIEN, on

THE GENESIS OF THE CRYSTALLINE IRON ORES.

(Abstract.)

Theories of two classes have been advanced, referring the origin of the crystalline ores to extraneous and indigenous origin. Under the first class, three may be mentioned:

1. Meteoric fall.—This was suggested in reference to the huge hematite deposit of Cerro de Mercado, in Mexico.

2. Eruption as dykes.—A theory advanced to account for many foreign deposits, and also those of Huronian age in the vicinity of Lake Superior, etc.

3. Sublimation into fissures.—A theory founded on the observation of crusts of specular oxide of iron in the lavas of Vesuvius, etc.

Objections to these theories were briefly presented. The theories attributing the origin of crystalline ores to indigenous origin are of two kinds, chemical and mechanical. Several chemical theories have been proposed:

4. Concentration from ferriferous rocks, or lean ores: if silicious, by thermal solutions: if calcareous, by carbonated waters. Subaerial processes of this kind cannot account for the origin of submarine sediments, such as the crystalline iron ores.

5. Saturation of porous strata by infiltrating ferriferous solutions.—Such a process could not produce huge bodies of pure ore, nor the alternation of pure materials in the lean laminated ores.

6. Infiltration into subterranean chambers.—The form, lamination,

and coincidence with the bedding planes, separate the ore bodies of crystalline character from recent deposits formed in this way.

7. Derivation from deep-sea deposits.—The form and structure of the nodules in the ooze differ widely from those of the ores under discussion, while the strata associated with the latter are evidently shallow-water deposits.

8. The metamorphism of ancient bog-ores.—This theory, now commonly accepted and taught in all the text-books, is unsatisfactory, from the absence of evidence, within the crystalline strata, of any terrestrial or subaerial surfaces on which such bogs or marshes could have rested; all the surfaces appear to be submarine.

Two theories of mechanical origin remain yet to be considered:

9. Violent abrasion and transport, by volcanic agencies combined with powerful currents.—To this it has been properly objected that the results of such violent agencies would be altogether conglomeritic.

10. Concentration and metamorphism of iron-sands.—Abundant instances of such concentration are shown along our coasts, and the deposits found along the St. Lawrence often contain but five or six per cent. of siliceous impurity. As the loose sands so concentrated consist at various localities of quartz, garnet, chrysolite, menaccanite, magnetite, etc., so we find in the metamorphic rocks their indurated counterparts, quartzyte, garnetyte, dunyte, menaccanyte, magnetyte, etc. The intermixture of garnet with magnetite, or its intercalation in separate alternating beds, is as common in the rocks as in the present oceanic sands. The thin interlamination of magnetite, martite or hematite with jasper, in the Huronian jasper-schist, corresponds to the still more frequent association now found along our sea-beaches. The abundance of ore beds of pure magnetite, free from apatite, in the strata of the Lower Laurentian of Ontario, and of menaccanite, more or less mixed with the other ore, in those of the Upper Laurentian of Quebec, Canada, appear to correspond with the general distribution of magnetite grains through the gneisses of the former, and grains of menaccanite through the anorthosites and traps of the latter formation. In bog ores no concentration of titanic acid has ever been found; its abundance in the form of menaccanite seems to necessarily involve a mechanical origin, and a vast source of that mineral is presented in its form of fine distribution through the rocks mentioned.

DISCUSSION.

Dr. J. S. NEWBERRY said that he would not claim that the chemical theory best explained the origin of all bodies of iron ore, but, he thought, it was applicable to most. It was not limited to mere terrestrial deposits like bog ores, but equally well accounted for marine

deposits like the the Clinton ore, which in his view was most like the magnetites and hematites of the Archæan rocks. At various places iron-sands are accumulating on our present coasts, as at Moisé, on the St. Lawrence, on Long Island, and on the coasts of Japan and New Zealand. It is only reasonable to suppose that such accumulations took place in ancient times, and that these were represented in some of the ore beds now known. The suggestion of Mr. JULIEN was new and important; but various facts, such as the presence of phosphorus, the absence of foreign minerals and the retention of limonite structure, seem to indicate that nearly all of our important iron ore deposits had been formed by chemical rather than organic processes.

Prof. D. S. MARTIN then remarked upon

A NEW EURYPTERID FROM THE CATSKILL GROUP.

(Abstract).

The specimen of the fossil referred to had recently been seen by him in the State Geological Collection at Albany. The family of the Eurypterids forms an exceedingly interesting group of crustaceans, constituting, with the Trilobites and the Xiphosura or Limuloids, the order Merostomata—which has by some authors been separated from the other crustacea and raised to the rank of a distinct class, or at least sub-class. The existing *Limulus*, or "horse-shoe crab," of our own sea-coast, is a familiar type of the group, which is otherwise almost wholly extinct; its relations to the other orders were briefly referred to. The Eurypterid family was best developed in the Water-lime Group of the Upper Silurian, but has been found to range through a large part of the Palœozoic rocks, both of our own country and of Europe—Mr. Walcott's lately-described genus, *Echinorhynchus*, carrying it down to the Utica Slate of the Lower Silurian, while others are known even as high as the Carboniferous. The specimen in question consists of a very large head-shield—nearly a foot in length and breadth—and is named *Stylopurus excelsior*. It was found in the Catskill group, at Andes, in Delaware County, N. Y., and from its form and the position of the eyes, has been referred to the genus *Stylopurus*, which has not before been recognized in this country.

DISCUSSION.

The PRESIDENT stated that the original specimen, to which reference was made by Prof. Martin, was now in the possession of Prof. Geo. H. COOK of New Jersey. The rocks of the Catskill group were generally barren of fossils, only a few fishes and plants having been found. It was a local deposit, probably of fresh water origin, corresponding in character to parts of the Old Red Sandstone of England, but it was not

of Devonian age. The coal measures of Pennsylvania contain similar crustacea, many having recently been discovered at Darlington.

October 23.

SECTION OF GEOLOGY.

The President, Dr. J. S. NEWBERRY, in the Chair.

Forty-two persons present.

The resignation of Mr. STRANG was accepted.

The following specimens were exhibited: by Mr. G. F. KUNZ, white pyroxene, found associated with white garnet in the vicinity of the Gatineau River, Canada, and also geodes of calcedony, filled with water, from Uraguay; by Mr. W. F. CHAMBERLIN, a garnet weighing 2 pounds and 11 ounces, $3\frac{3}{4}$ inches in diameter, with faces curiously striated parallel to the lines of cleavage, found on New York Island, near 145th street, where another had been also seen, 5 inches in diameter, but broken.

The PRESIDENT remarked that he had found geodes in cavities of the tufaceous rocks of Oregon. These had been once filled by hot water, carrying silica in solution, then partly or completely occupied by a deposition of agate, onyx, etc., and on the erosion and removal of the surrounding matrix, the geodes remained, thus representing casts of the cavities.

A series of TRUBELOW'S astronomical drawings was then exhibited by Dr. NEWBERRY, and pronounced the most striking and satisfactory ever made.

Dr. N. L. BRITTON then presented the following paper, illustrated by a collection of fossils:

NOTES ON THE CRETACEOUS MARL-BELT OF NEW JERSEY.

(Abstract.)

The notes had been taken during a six weeks' collecting tour, in connection with the Geological Survey of New Jersey. The special object was to procure invertebrate fossils from the different marl beds and associated strata, in order to aid in the preparation of a report, on the invertebrate palæontology of the State, by Prof. R. P. WHITFIELD.

The geological structure, and the relations of the three marl beds, to the other Cretaceous and Tertiary strata, were described.* The beds are all referred to the Cretaceous Age, with the exception of the upper

* For a detailed description, see "Geology of New Jersey," 1868.

layers of the Upper Bed, which are supposed to belong to the Eocene Tertiary.

The strike of the marl outcrops is about S. 55° W., and these croppings extend from the Highlands of Navesink and Deal Beach on the Atlantic coast, to the head of Delaware Bay, the outcrops of the beds running in a general way parallel with each other. The Lower and Middle Beds outcrop at points throughout this entire distance of one hundred miles, while the Upper Bed croppings are not found further southwest than Glementon, about sixty miles from Deal Beach. Beyond this place the Upper Bed does not come to the surface and is not known to exist.

The strata dip toward the southeast about thirty feet to the mile.

The Lower Marl Bed.

This bed rests on strata of laminated sands, which compose the upper layers of the deposits called the "Clay Marls," from the nature of the materials of which they are constituted. These clay marls contain numerous fossils; but few openings have been made on them, as the material is less valuable for fertilizing purposes than the greensand marls occurring higher in the series. The component layers of the Lower Bed are: (1), two to four feet of sandy marl, containing a small percentage of greensand; (2), twelve to sixteen feet of blue marl, with much greensand and considerable carbonate of lime; and (3), a layer of about ten feet of clay and marl mixed, which shades off into (2), the upper part of (3) containing little greensand. Much sulphate of iron occurs in the upper layer, often rendering the marl very astringent.

One of the prominent features of this bed is the "shell layer." This stratum is about half-way through the blue marl (2), and is almost entirely made up of shells of *Gryphæa vesicularis*, Cuv. It varies from six to fourteen inches in thickness and extends entirely across the State. The shells are generally large—many of them six or eight inches across, frequently even larger—the convex valve commonly well preserved, the flat one mostly imperfect. The marl which underlies this "shell layer" contains the rarer fossils of the bed, mostly as casts, the substance of their shells being very generally removed. Above the shell layer are most of the more common fossils, whose shells are generally preserved. Among these are *Exogyra costata*, Say; *Ostrea larva*, Lam. (most abundant in the clay and marl layer (3); *Terebratella plicata*, Say; *Belemnitella mucronata*, Schloth (the phragmocones of this species are abundant at some localities); and *Neithea Mortoni*, D'Orb. (abundant in fragments). Under the *Gryphæa* layer occur most of the other fossils

of the Lower Bed, and it seems that, the deeper the marl is penetrated, the more numerous and varied do these become. Here occur the *Ammonites* and *Baculites;* the *Pectens, Cucullæas, Arcas, Cardiums* and the many forms of gasteropods.

Above the Lower Marl Bed lies a stratum of sand, colored more or less red by sesquioxide of iron, and hence termed the "Red Sand Bed." This attains in places a thickness of one hundred feet and contains Lower Bed fossils, as at Mullica Hill, where the very numerous fossils are found in a hard indurated marl, which there occurs near the summit of this Red Sand Bed.

The Middle Marl Bed.

This overlies the Red Sand and is composed of three well defined layers, viz.:

(1), A green marl layer, made up almost entirely of greensand grains; this merges into the indurated marl of the Red Sand Bed, or into a chocolate colored marl, in its southwestern extension. This layer contains few shells, but many bones and teeth of saurians; and some very perfect skeletons of *Mosasaurus*, etc., have been taken from it.

(2), A shell layer; this is another feature in the marl bed geology. It averages about five feet in thickness, and is composed of two species of shells, thickly imbedded in greensand. The lower two-thirds of its thickness are made up of *Gryphæa vesicularis*, Cuv., of a very uniform size—about three inches across—none of the very large ones which compose the shelly layer of the Lower Bed being here observable. The upper third is composed of shells and casts of *Terebratula Harlani*, Mort., and occasionally some of the very closely allied *T. fragilis*, Mort. The *Terebratulas* are commonly called "squirrel-heads," and when well preserved make beautiful fossils. This shell layer extends from Long Branch to the Delaware. It is overlain by (3), the stratum of limestone and less compact limesand, generally of a white or light yellow color, which forms the top of this bed and is a deep water deposit. It is thickest in the southwestern part of the marl belt, attaining a thickness of over twenty feet in Salem County. It may be traced entirely across the State, being observable, on the Atlantic coast, about Long Branch, where the rock is occasionally washed out by the waves. Here, however, its thickness is much less. In Monmouth County, it is almost all "limesand," but parts of it become more compact as we proceed southwestwardly, and the rock is sufficiently hard to be burned for lime.

This stratum contains numerous fossils. Bryozoa of many species

occur, the most common one being *Eschara digitata*, Mort. A few foraminifera of quite large size have been found at this horizon in Monmouth County. The spines of echinoderms are abundant, and rarely a well preserved test is found. The coral, *Montivaltia Atlantica*, Mort., occurs (scarce). Quantities of *Polorthus tibialis*, Mort., the tubes varying greatly in size, and some other small lamellibranchs occur; there are also a few gasteropods. The coiled articulate, *Spirulæa rotula*, Mort., is abundant.

The limesand layer becomes somewhat mixed with quartz sand in its upper portion, and finally changes into the Yellow Sand Bed, which is forty or fifty feet thick in Monmouth County, but only ten to twenty feet thick in the western part of the State. This stratum is barren of fossils.

The Upper Marl Bed.

This rests on the Yellow Sand. As has already been stated, its outcrop is not so extensive as those of the other two beds; for further southwest than Clementon, Camden County, it has not been noticed. Its greatest development is in eastern Monmouth County, in the vicinity of Farmingdale, Squankum, Shark River and Deal Beach. Here it is represented by:

(1), Seventeen feet of green marl, mainly composed of glauconite (greensand), with numerous fossils. Among these may be noted the lamellibranchs, *Cyprina Morrisii*, Con., *Crassatella Delawarensis*, Gabb, and a small unnamed *Gryphæa*; two or three species of gasteropods, which are not abundant; the coral, *Trochosimilia conoides*, Gabb and Horn; the echinoderm, *Nucleolites crucifer*, Mort., and numerous teeth of sharks and rays of several species.

(2), About eight feet of the "ash marl," so-called from the ashy appearance of the heaps. This contains no greensand, but is composed of fine quartz sand, mixed with a greenish white clay; it is nearly barren of fossils.

(3), About eleven feet of blue marl, which tops this series of marl beds. The upper two to four feet of this layer is a hard, rock-like, light blue substance, which is full of fossils and has been referred to the Eocene. This stony marl is well exposed at Shark River, Deal Beach, and along the Manasquan River, near Squankum, but is unknown in the western continuation of the bed. Among its fossils are the large coiled cephalopods, *Nautilus Dekayi*, Mort., and the rarer *Aturia Vanuxemi*, Conrad; the conchifer, *Venericardia perantiqua*, Con., which is the most common fossil occurring in it, and several other bivalves and gasteropods of a large size, abundant and of several species.

From the eastern Monmouth County localities, above mentioned, to

the vicinity of New Egypt, Ocean County, a distance of thirty miles, there are no outcrops of the Upper Marl Bed. When it reappears at the last mentioned place, the layers referred to the Eocene are absent, and they do not again appear further towards the west.

The fossils, *Crassatella Delawarensis*, Gabb, and *Nucleolites crucifer*, Mort., are more abundant at New Egypt than in eastern Monmouth County. Here occurs also another unnamed bivalve, in the green marl layer, which has not been noticed about Farmingdale, etc. This green layer is dug at Poke Hill and Vincentown, Burlington County, and contains the shells of a small *Gryphæa*, apparently *G. vesicularis*, Cuv., in a dwarfed condition, about one and a half inches across.

DISCUSSION.

Mr. G. F. KUNZ remarked that he had observed abundant cretaceous fossils at Ruby's, including a piece of amber of the dimensions of 1 by 6 by 20 inches: also, at Mullica Hill, dufreynite, vivianite, etc., in abundance, the latter sometimes in crystals one inch in length.

Dr. BRITTON stated that vivianite occurred in great abundance in the sands of the lower marl-bed, entirely replacing many of the shells; also at the well-known locality, still unexhausted, at Mullica Hill, in radiated forms and often occupying the casts of belemnitella; at Colson's Pits, on the drift; in clays on the Delaware River, at Fishhouse Station, etc.

A paper was then read by Dr. J. S. NEWBERRY,

ON THE ORIGIN OF CRYSTALLINE IRON ORES.

(Abstract.)

At a recent meeting of the Academy, Dr. JULIEN read an interesting and instructive paper on the origin of crystalline iron ores, in which he attempted to show that they are the product of mechanical rather than chemical agencies.

In bringing this subject again before the Academy, it is not my purpose to attempt to refute, but rather to supplement and limit, the theory of Dr. JULIEN.

I will not deny that some of the beds of magnetic iron ore, described by Dr. JULIEN, in the Alleghany belt, have been formed by the sorting power of shore waves, and that he has made an important contribution to the literature of iron, by his careful study and description of these beds; but that such cases, if they exist, are exceptional, and do not affect the truth and validity of the organico-chemical theory, I shall endeavor to prove by a brief report of some facts which have come under my observation.

The most important deposits of iron ore, known to exist in the United States, may be grouped as follows:

1. Magnetic ores of the Laurentian rocks of Canada, the Adirondacks, and the Alleghany belt.
2. The Huronian hematites of Lake Superior and Missouri.
3. The crystalline ores of the Rocky Mountains and the Wasatch.
4. The limonite ores of the Atlantic slope and the Mississippi Valley.
5. The Clinton ores.
6. The carbonates of the Coal-Measures.
7. The spathic carbonates of New England, Idaho, etc.

The Laurentian magnetites form lenticular sheets, sometimes more than one hundred feet in thickness, and extending half a mile or more. In many instances they are enclosed in walls of gneiss, slate, or marble. They often contain much titanium, and have, as almost universal impurities (somewhat vicarious with titanium,) pyrite and apatite. Some of the beds are also highly charged with manganese; they usually contain but little silica and alumina, and are the richest of our iron ores.

The characters they present, which seem incompatible with the theory of mechanical accumulation, are the following. First, their great magnitude, combined with their prevailing purity. Secondly, the large quantity of apatite contained, which we must regard as of organic origin and therefore supporting the chemical theory, and so different from the magnetite in gravity as impossible to be mingled with it by any mechanical agency. Thirdly, the occurrence of great sheets of magnetite between strata of limestone, like the Franklinite ore, or enclosed in layers of limestone and argillite, like the bog-bed at Marmora, Canada. The fact, that the slate and the limestone are deposits from deep and quiet water, seems incompatible with the view that these strata have been brought into their present association by mechanical means. Fourthly, the frequent impregnation of magnetites with manganese, a material of much lighter gravity, and an almost constant constituent of limonite, goes far to prove such magnetic beds chemical rather than mechanical deposits. Fifthly, the aluminous magnetites, like that of Croton Landing, which contain almost no silica, could hardly have been formed by the agency of shore waves, which always mingle more or less sand with whatever they deposit.

For these reasons, I must consider the mechanical theory as inadequate to account for the genesis of most of the magnetites of Canada and the Eastern States.

The specular ores of Lake Superior and Missouri offer objections to the mechanical theory, in both their regularity of deposition, and their mineral character. First, they are sometimes interstratified with jasper —once fine silicious sand—in layers of great regularity and of extreme

thinness: a structure which would be the natural product of sedimentation but hardly of mechanical washing. Secondly, they could never have been deposited as hematite by shore waves, since this mineral forms an impalpable powder which never accumulates by itself. We must therefore suppose that all these great iron ore beds are pseudomorphs after magnetite, or that they are the result of sedimentation by organic agencies and subsequent metamorphism.

The iron ore of Iron Mountain is enclosed in "porphyry"—probably a metamorphosed sediment really fused in place,—but some of the masses of ore are thickly set with crystals of apatite, which afford an equally conclusive argument against the volcanic and the mechanical theories. In the ore of Simmons Mountain, masses of magnetite occur which retain perfectly their radiated, limonite structure; and there can be no question but that this has been deposited by a chemico-organic process.

The deposits of magnetic iron in Southern Utah,—the most extensive of which I have any knowledge,—are in places very conspicuously and evenly stratified and thus exhibit all the signs of having been deposited as sediments. They are associated with limestone and a granitoid metamorphic rock. Along certain lines, the ore is thickly set with crystals of apatite, and some of the largest masses are in great part composed of magnetite, which shows everywhere limonite structure. From these facts it is easy to see that these great deposits have not been formed by mechanical agencies.

In regard to the sparry carbonates which form vein-stones, and the earthy carbonates of the Coal measures, there can be no question of their origin. They have all been formed by chemical precipitation.

The Clinton ores are interstratified with limestone, form continuous sheets of great extent, and constitute on the whole the most considerable deposits of iron ore in this country. They were apparently formed in the same way that the granular lake ores are now deposited, by the precipitation of iron from solution in a water basin, surrounded by land having a ferruginous drainage. The quantity of phosphorus they contain, derived from the organic matter deposited with them, is a conspicuous feature in the composition of the Clinton ores, and apparently explains its abundance in many of our crystalline ores. After a careful study of the structure, composition and surroundings of our most important deposits of magnetic and specular ores, I am compelled to conclude that they have generally been derived from stratified deposits, accumulated by chemico-organic agencies, and once closely resembled our stratified ores of the upper Silurian and Devonian; and that any beds which accumulated as iron sand on beaches must be rare exceptions to the general rule.

DISCUSSION.

Mr. A. A. JULIEN pointed out that the theory thus presented by Dr. Newberry was a new one, and might be designated as the "Lake ore theory," in contradistinction from the marsh or bog ore theory now commonly accepted. The difference is sharply defined in the following quotations from the Manual of Geology by Prof. J. D. DANA. In his discussion of the Upper Silurian deposits, that author states (p. 231): "the beds of argillaceous iron ore . . . could not have been formed in an open sea, for clayey iron deposits do not accumulate under such circumstances. They are proof of extensive marshes, and, therefore, of land near the sea level. The fragments of crinoids and shells found in these beds are evidence that they were, in part at least, salt water marshes, and that the tides sometimes reached them." Again he remarks (p. 357), concerning the American continent during the Carboniferous age: "It may have been long a region of barren marshes, and in this condition it might have received its iron ore deposits, as now marshes become occupied by bog ores."

In reference to the Laurentian deposits (p. 155), he states: "Limestone strata occurred among the alternations, and argillaceous iron ores, though vastly more extensive." And again, "the argillaceous iron ore has become the bright hematite or magnetite, and it is banded by or alternates with schist and quartz, etc., which were once accompanying clay and sand-layers."

However, it is hard to conceive the growth of crinoids and shells in salt water marshes, even if reached by the tides, in the free abundance indicated by the crowded organic forms in the Clinton ore beds, and of these the lake ore theory presents a more satisfactory explanation. It also well accounts for the origin of the enormous ore deposits of hematite, of magnetite still retaining a pseudomorphous structure after limonite, and of all iron ores rich in calcium phosphate. This theory is not necessary to account for the presence of pyrite, since the presence of any vegetable matter, *e. g.*, algæ growing and decaying in sands or mud, is always likely to produce the de-oxidation of sulphates and iron oxide; nor does it account at all for the abundance of titanic acid and alumina in many iron ores.

On the other hand, the mechanical accumulation of iron sands, by agitation of the waves and currents, would appear to account more simply for the smaller but more numerous deposits thickly dispersed throughout the crystalline rocks, varying in size from scattered grains to little flakes and lenses a few centimeters in length, and even thick ore beds many meters in thickness and diameter. The close association, often observed, of materials of widely different specific gravity, e. g., shale and limestone with the magnetic ores, need not appear anomalous,

since they may all have a shallow water origin, deposited by marine currents differing in force and direction at different times. The absence of such mechanical deposits from the sedimentary formations is not established, since even some of the hematites and bog ores may represent the results of oxidation and hydration of original magnetite sands; while, on the other hand, the huge beds of menaccanite found in Canada and elsewhere, which have not yet found their parallel among the sedimentary strata, may indeed show a certain difference of conditions during the deposit of the ancient crystalline rocks. The comparative regularity of the thin alternating laminæ, which make up the ferruginous jasper schists of Huronian terranes, appears analogous to that everywhere prevailing in a cross section of beach sands along our oceanic border; while the mountain masses of this rock, with laminæ of magnetite, or of octahedra of martite after magnetite, or of hematite in triangular scales after martite—all these ores being remarkably free from calcium phosphate—are most simply explained by the accumulations upon a sea bottom, strewn alternately with fine silicious silt, and with octahedra of magnetite. The presence of manganese oxide in iron ores may often be due, as at the Buckhorn mine in North Carolina,* merely to the decomposition of a manganese garnet originally concentrated as a mechanical sediment, while the concentration of titanic acid and of alumina, in many iron ores, is perfectly explained by the accumulation of heavy sands of menaccanite, corundum, etc. In a magnetic iron ore of S. G. 4.5, occurring in serpentine at South Ham, Quebec, Canada, the percentage constitution reported † (Fe 44.69, Cr^2O^3 8.31, TiO^2 21.64) is equivalent to a mixture of three minerals known to occur in iron sands: magnetite, 50, chromite, 13, and menaccanite, 37 per cent.

The consideration of these facts would lead to the conclusion that the mode of genesis of a bed of magnetic iron ore may be often determined by the following diagnosis:

When the ore presents structural characteristics allied to those of limonite, or when hematite occurs in included masses, or when the ore contains a notable amount of phosphorus, a chemical origin is probably indicated.

When the ore is almost free from phosphorus or is rich in titanic or chromic acid or alumina, or closely associated or mixed with granular garnet or olivine, a mechanical origin may be inferred.

Mr. N. F. DARTON stated that he had found over two per cent. of chromic acid in the limonite ores of Staten Island, and Mr. N. L. BRITTON, from 1.6 to 3 per cent. in the ores of the same region.

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* W. C. Kerr, Geol. of N. C., I, 222.

† B. J. Harrington, Can. Nat., 1881, IX, 309.

October 30, 1882.

SECTION OF PHYSICS.

The President, Dr. J. S. NEWBERRY, in the Chair.

Fifty-two persons present.

The following specimens were exhibited:

By the PRESIDENT, proustite or ruby silver from Chile, remarkable for rich color and beautiful crystallization.

By the SECRETARY, wad (bog manganese) from Norwich, Vt., made up of aggregated nodules easily crushed by the fingers and entirely dissolved in chlorhydric acid. It is found near outcrops of mica slate, on high ground overlooking the Connecticut river, in a bed six inches thick, directly below the turf of a pasture, and in masses of 6 or 8 pounds.

Also soapstone, from one of two transported masses, lying above high water mark on the west bank of the Connecticut river, at Olcott's Falls, Norwich, Vt. These masses are about 6 ft. x 2 ft. x 1 ft. each, entirely unworn, and transported, we may fairly conclude, in the glacial period, and from the nearest northern locality, which is Sunday Mountain in Oxford, N. H., about 20 miles directly north. No transported masses of this material are mentioned in the Geological Reports of New Hampshire or Vermont.

The PRESIDENT remarked on the somewhat frequent occurrence of such forms of "bog manganese," and the similarity of its production, in the chemical processes involved, to that of "bog iron ore."

A paper was read by Prof. W. P. TROWBRIDGE, entitled,

IMPORTANCE OF EXPERIMENTAL RESEARCHES IN MECHANICAL SCIENCE.

(Published in full in the *New Englander*, February, 1883.)

The following paper was read, by Prof. JOHN K. REES:

RESUMÉ OF OBSERVATIONS ON GOULD'S COMET (NOW VISIBLE).

I. Discovery.

In accordance with the custom of naming a comet after its discoverer, it appears that this grand visitor to our system should be called Gould's Comet. M. CRULS, of Rio de Janeiro, saw the comet in the morning sky on Sept. 12th, and, as he was thought for some time to have been the first to see the comet, it was called after him.

DAVID GILL, writing from the observatory at the Cape of Good

Hope, remarked that Mr. FINLAY, the First Assistant, saw the comet at 5 A. M., Sept 8.

Dr. GOULD, of Cordoba, in a letter dated Sept. 15, to S. C. CHANDLER, Jr., of Boston, stated that he had been observing a large comet for over a week. This undoubtedly was the one now visible, and Dr. GOULD appears to have been the first to see it.

The comet was first observed in England, by Mr. A. A. COMMON. He was observing the sun "with a special telescope (reflector with glass reflecting surfaces only)," on the morning of September 17th, when he found a "bright comet," "five minutes preceding the sun, and approaching fast." This observation was made at 10.45 A. M.

Mr. CRULS thought his comet might be the expected Comet Pons of 1812. This is considered an oversight, as the comet of 1812 should appear much *further north or south* of the present comet, depending on whether the 1812 comet was approaching, or receding from, perihelion.

Since the discovery of this grand comet, much attention has been given it by observers here and abroad. The bad weather has greatly interfered with the observations.

II. Aspect and Form.

This comet will rank among the remarkable comets of the century. Mr. COMMON, as we have mentioned, saw the comet close to the sun at almost noontime; and Mr. GILL observed the "*sudden disappearance of the comet at ingress on the sun's disc.*" The comet was not visible on the sun. "Mr. Gill's remarkable observation," says *Nature*, "is without a precedent, and an extraordinary illustration of the intense brilliancy which the comet attained at perihelion." The comet swept around the sun, passing the perihelion point in three and a half hours. The velocity in turning about must have been enormous.

The tail, before the comet passed around the sun, does not seem to have been of any great visible extent. Mr. COMMON estimated the length of the tail, on the 17th of September, just before reaching the perihelion, as 4′ in length. But the bright sunlight undoubtedly hid from view much of the tail's faint light.

Since the passage of perihelion, many observers have been watching the comet with every means in their power—telescope, spectroscope and polariscope.

M. BULARD, of Algiers, gives, in *Nature* for Oct. 12, a drawing of the head of the comet, showing the system of envelopes rising from the nucleus. Several recent bright comets have exhibited this same peculiarity.

In *Nature* for Oct. 19, sketches by RICCO of Palermo are given. Prof.

YOUNG, at Princeton, has sent me a letter from which I obtain the following data:

"The weather has been so bad here that we have been able to make but few observations of the comet.

"I send a note, from the *Siderial Messenger*, of observations made here on the 19th and 20th of September. It has since been observed at the Halsted Observatory (with the 23-inch telescope) on October 2, 4 and 15 (*civil time*), and at the S. S. Observatory with the 9½ telescope, on the 10th and 24th.

"On the 2d, the Spectrum showed very plainly the D lines in addition to the usual cometary (carbon) bands.* There was no sensible displacement due to motion. In the middle carbon band (near *b*), the three bright lines, observed in the comet of 1881, came out finely. No dark lines could be seen, though there was a pretty strong continuous spectrum from the nucleus of the comet.

"On the 4th, the D lines were barely visible, and since then the spectrum has been simply that ordinarily shown by comets. The three bands have been visible in the spectrum of the tail to a considerable distance from the head. This I mention in opposition to the statement (which I think a mistake) that the spectrum of the tail is simply continuous.

"*In the Telescope.*— On the 2d, the nucleus was elliptical, about 4″ by 8″. There was one well-formed parabolic envelope, and there was a *dark* streak following the nucleus. The edges of the streak were nearly parallel, pretty well defined, and it could be followed for about 20′, till it lost itself in the tail.

"On the 4th, the nucleus had become much elongated—something like an Indian club in form—large end towards the sun. The envelope had lost all definiteness of outline. The dark stripe beyond the nucleus was very faint, and along the northern edge of it there was a *bright* streak.

"On the 10th, the nucleus had assumed the appearance it has since retained, consisting of a spindle-shaped, slightly curved, nebulous streak of light, with five or six knots or centres of brightness scattered through it. The brightest of these knots (perhaps the true nucleus)

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* In the Dun Echt circular No. 56, sent from Lord Crawford's Observatory, England, we read: "The spectrum of the nucleus continuous, with many bright lines, of which D is by far the brightest; all the bright lines displaced towards the red by about one-eighth of the interval of the D lines." This separation would correspond to a motion of *recession* of about twenty miles per second. Prof. YOUNG's observation was made after the comet had passed perihelion; so also were the observations made at Dun Echt. The date of the Dun Echt observations was September 18. If a displacement showing motion really occurred, it will be the first time that such a phenomenon has been noted with reference to a comet. The observation is one of such delicacy that we must wait further corroboration before accepting the Dun Echt observation, especially as Prof. YOUNG has not been able to discover any sensible displacement.

was the *third* from the sunward end of the spectrum; the fourth was nearly as bright, and the nebulosity between them was so much fainter than elsewhere, that in a small telescope, or in the large one after day-dawn, the nucleus seemed to be broken in two at this point.†

"The nuclear streak was slightly curved, and the knots in it were a little out of line. A bright wisp extended from the end of it out into the tail. These appearances were well seen on the 10th with the 9½-inch glass, and still better on the 15th with the 23-inch; on the 24th the moonlight was very strong, and the comet rather faint, but the same features could be still made out.

"On the 15th, the nuclear streak measured 48″ in length.

"On the 15th and 24th, the companion comet was looked for, but I could not find it.

"On the 2d, the head of the comet was brighter than Regulus, but not so bright as Sirius. It disappeared in the dawn, before Procyon even, but Procyon was farther from the sunrise. The tail was very bright, and well defined at both edges—about 14½° long.

"On the 4th, the head equalled Regulus. On the concave side of the tail (the northern), there was near the head a good deal of scattered nebulosity, visible to the naked eye, and veiling the outline of the tail in that region.

"On the 10th, nothing of special interest was noted, except that the outline of the tail, near the head, was less definite than before.

"On the 15th, a very curious phenomenon* was noted, to which my attention had been called by a letter from Prof. SMITH, of Kansas State University. From the head of the comet there extended toward the sun a faint streamer of light, about ½° wide, with nearly parallel edges, which were pretty sharply defined. It seemed to originate in the *tail* of the comet, a degree or so above the head, and extended towards the sun about 3½° or so below the head, being 4° or 5° long in all. It faded away at the lower (sunward) end, without any definite boundary. It could be faintly made out with the naked eye, but was best seen with a small telescope of two inches aperture, magnifying about ten times.

"The tail was nearly 20° long, and distinctly forked at the end, the convex side being prolonged by an oblique streamer. Head on the 15th brighter than α Hydræ, not so bright as Regulus. On the 24th, the head was about fourth magnitude star. I believe this embodies everything of importance noted here."

† This will account for the many reports of the breaking up of the nucleus of the comet. Three condensation points were noted at Washington with the 26-inch glass, but nothing like a *split* was observed.

* This same phenomenon was observed at Washington as early as October 8, when the sunward appendage was between 30′ and 50′ long, and on the morning of the 10th it was 3° long.

III. Orbit and Motion.

Prof. BOSS, Director of the Dudley Observatory at Albany, was the first to point out the supposed identity of this comet with the comets of 1843 and 1880, and prophesied its speedy return.

Mr. HIND'S elements also lead us to believe that the 1843 comet and this one are the same.

Mr. PROCTOR explains, in the last number of *Knowledge*, how he was misled, by the careless marking of a diagram, into a promise to show that the great comet is to be seen where the comets of 1843 and 1880 could not have been seen. "I am unable to do so," he says, "simply because there is every reason to believe that the comet, which circled close around the sun on September 17, is no other than our friend, the Menacing Comet, come back in less than two years and eight months. The observations agree so well with the theory that the comet is moving in the orbit of the comets of 1843 and 1880 (at least in the part of the orbit near the sun, for at aphelion the orbit has been entirely changed), as to leave scarcely any room for any doubt that the comet has come back again long before it was expected—how soon to return yet again, and how soon to be finally absorbed by the sun, it were at present somewhat rash to say." But after some further calculations, he says: "for my own part—so far as observations hitherto made enable me to judge —I expect the comet back in less than half a year."

Some of you will recall the grand comet of 1843. All remember the beautiful appearance of the comet of 1880. The period calculated for the 1843 comet was 175 years. If the supposition of Prof. BOSS is correct, we have a change in the period of the comet from 175 to thirty-seven years, and then to about three years. This immense change must be ascribed to the resistance the comet meets with in passing so close to the sun's surface, thus diminishing the linear velocity of the comet, but increasing its angular velocity, and shortening its time of revolution. The inevitable result of this must be a precipitation of the comet into the sun.

The comet of 1843 came within 500,000 miles of the sun's centre, or 70,000 miles of the sun's circumference. The comets of 1880 and of 1882 came nearly as close, if not closer. We know that the terrible solar cyclones and volcanoes, if I may use the term, throw up masses of hydrogen and other gases to a height more than sufficient to surround the head of the comet, when so near the sun. Moreover we know that the mysterious coronal atmosphere extends many millions of miles out from the sun. Thus the comet has to plough through this atmosphere, and one would expect as a result a retardation in the motion of the comet.

The result of this retardation would be a shortening of the comet's period ; and, after a few returns, the comet would not have sufficient centrifugal force to overcome the sun's attraction, and so would plunge into the photosphere. Although this plunge might be made at the velocity of 200 miles per second (according to PROCTOR), yet no results disastrous for the earth are likely to follow. The study of the comets, at their successive returns, shows us that they decrease in mass and size, owing to the heat of the sun ; and moreover the mathematical astronomers have never been able to find the least effect of the attractions of the comets on the planets or satellites.

Comets have been entangled among the satellites of our planets—notably, LEXELL'S comet of 1770, and have been swung off in the planets' attraction to pursue totally different orbits. Yet the comets never affected the motions of the smallest satellites, thus showing that the mass of comets must be small compared with the planets and satellites. The result, therefore, of a collision with the sun, might be only a solar disturbance, which would evidence itself in a large spot and cause a display of auroras here, and the swinging of the magnetic needles. At least the mathematical chances are in favor of some such slight disturbance. But if this comet is to return in about six months, it may be our good fortune to test the truth of these statements very soon. Per contra, there are those among the astronomers who do not consider that the identity of the comets of 1843, 1880 and 1882 have been proved.

Mr. S. C. CHANDLER of Harvard Observatory points out the fact that the orbit of the comet of 1843 was computed from observations after its perihelion passage, and therefore *after it had experienced all the perturbing effect* of the passage so close to the sun ; it was found that it could not return for 175 years, and that the orbit of the comet of 1880 was in like manner computed from observations after its perihelion passage, and that comet cannot return for at least ten years. He now computes the orbit of the present comet, representing all observations from nine days before the perihelion passage to thirty-two days after it, and shows, not only that its orbit is an ellipse so extended that the comet cannot return for many years, but also that the passage in close proximity to the sun did not materially affect the orbit. This testimony is a severe blow to the theory of the identity of the comets of 1843, 1880 and 1882.

[The paper was supplemented by explanatory remarks in regard to the chemical and physical constitution of comets. In the lantern exhibition, the following points were dwelt upon. 1. Connection between comets and meteors. 2. Various forms of comets. 3. Observations made on the tails of comets. Theory of a repulsive force emanating from the sun. 4. The immense extent of the sun's "atmosphere" through which some comets plunge.]

November 6.

SECTION OF GEOLOGY.

The President, Dr. J. S. NEWBERRY, in the Chair.

Thirty-six persons present.

The following persons were elected as Resident Members:

E. L. SNOW, J. MCDONALD,
N. A. DARTON, C. E. PELLEW;

and, as Corresponding Members:

H. A. ALFRED NICHOLS, of Dominica, W. I.

F. W. STOEBNER, of State Normal School at Westfield, Mass.

The following resolutions were passed by unanimous vote:

Resolved, That authors of papers offered for reading before the Academy be earnestly invited to present them previously in full, or in satisfactory abstract; and that, except by vote of Council, preference shall always be given by the Committee on Papers to those which shall be so presented in writing.

Resolved, That all addresses or remarks before any meeting of the Academy, on scientific subjects or on business, which may not have been previously accepted and announced on the weekly card, shall be limited (with the exception of the Reports of Council, Officers or Committees) to five minutes, unless by special vote and permission of the Academy; and they must at any time be discontinued at the request of the Chairman, whenever in his judgment they are not pertinent to the subject before the Academy.

A communication was received from JAS. C. COX, M. D., President of the LINNEAN SOCIETY of Sydney, New South Wales, announcing the entire destruction by fire, on September 22, of all its property—library, correspondence, records, instruments, and collections—in the burning of the Garden Palace, a loss estimated in money at £3,000. On motion, it was resolved to send an expression of the regrets and sympathy of the NEW YORK ACADEMY OF SCIENCES and to supply the Linnean Society with as complete a series as possible of the Annals and Transactions of the Academy.

Mr. G. F. KUNZ remarked on an interesting series of minerals, collected during the past summer by Mr. C. D. Mimms, of Philadelphia, Jefferson County, N. Y., from a new locality at the village of Fine, St. Lawrence County, N. Y., twelve miles from Edwards and forty miles from Philadelphia, N. Y., on the border of the Adirondacks. Titanite occurs in very large crystals, only equaled by those of Renfrew, Canada, one group of three crystals measuring

over 30 centimeters across and weighing 45 pounds, a single crystal weighing 20 pounds, etc.; all the faces are unpolished. Pyroxene is found in huge crystals, one being 120 cm. long and 45 cm. through. Orthoclase, in crystals 5 to 15 cm. through. Zircon and fine green fluorite also occur.

Mr. KUNZ also exhibited minerals, from a new locality at Stoneham, Maine, which very much resemble those described by Profs. Dana and Brush, from Branchville, Conn. Among these may be mentioned triphylite, triplite, damourite, spodumene, and a pink mineral, as yet unidentified. He had also recognized topaz, a mineral new in that association, never before found in that State, and known to occur at but one locality in New England. A crystal of this mineral observed was well-formed but much broken, and measured 38 cm. across the brachydiagonal; though others, 15 to 18 cm. in length, were destroyed in the process of blasting. He also exhibited a specimen of chalcopyrite, in a rare association, with pyrrhotite and pyrite, from Untersalzbach, Tyrol.

A paper was read by Mr. N. F. DARTON, entitled:

ON THE GENESIS OF THE ORES AND MINERALS IN THE GRANULAR LIMESTONE OF SUSSEX COUNTY, N. J.

DISCUSSION.

A *member* pointed out that the content of crystallized tourmaline, epidote, and beryl, in the "dykes of granite" mentioned by the author, identified these as granite veins instead of true eruptive dykes.

Prof. T. EGLESTON remarked that all the crystals of so-called "idocrase" from this region, which he had examined, turned out to be tourmaline.

Mr. G. F. KUNZ reported that fifty crystals of supposed "idocrase" from this region, now in the cabinet of the Pennsylvania Geological Survey, were really tourmaline.

Mr. DARTON stated that, at Sparta, the granite holding tourmaline, cut across the limestone beds, and might occur in true veins, and that he believed that crystals of idocrase from Franklin had been identified by analysis.

November 13, 1882.

SECTION OF CHEMISTRY.

Vice-President, Dr. B. N. MARTIN, in the Chair.

Sixteen persons present.

The following specimens were exhibited: by Mr. G. F. KUNZ, crocidolite catseye, from Cape of Good Hope: by Mr. JULIEN, a young echinus, curious shelly aggregates of sand, ten cm. in diameter, from the beach off the Navesink Highlands, N. J., and a fossil Ostrea, found in the boulder clay, in 112th street, between Ninth and Tenth avenues, New York city: by Mr. N. H. DARTON, supposed clintonite, from a vein five cm. thick in serpentine, at Honolulu, Sandwich Islands.

Prof. D. S. MARTIN identified the echinus as a very small and young individual of *Echinarachnius parma*, belonging to the New England coast at its southward limit, hardly ever found before on the beaches of New Jersey, though reported to occur on a far out bank.

The CHAIRMAN showed that the sandy aggregates were the egg-casts of a large species of the mollusk, *Natica*, known to occur along that beach, and that the fossil exhibited, probably *Ostrea*, was the first he had seen from the till of New York Island; and further remarked on the distribution of the oyster along the Atlantic coast of this continent.

A paper was read by Dr. PIERRE DE P. RICKETTS, entitled:

ANALYSIS OF THE FRANKLINITE ORES OF NEW JERSEY, AND METHODS FOR THE SEPARATION OF THE RED OXIDE OF ZINC.

(Abstract.)

Some time since, my attention was called to the question of determining a method for estimating the amount of Red Oxide of Zinc, contained in certain deposits of these Franklinite Ores. Some of the results obtained have not been published, other than in the testimony taken in law suits about these deposits.

The methods employed were briefly as follows:

The first was a mechanical separation, made by Mr. A. F. Wendt and myself, for the purpose of obtaining the mineral constituents of the samples treated, as nearly as possible.

The ore was crushed down to below 40 meshes to the inch, and sieved. The Franklinite was then extracted by the magnet from an average portion of the sample, and the red oxide separated by hand,

under a powerful magnifying glass, from the residue, by using a fine wire with a small hook at the end.

The result of the separation was:

	A.	*B.*
Franklinite	48.2 per cent	44.7 per cent.
Red Oxide	2.7 "	7.4 "
Silicates & Carbonates	49.1 "	47.9 "
	100.0	100.0

The next method adopted was to take average samples of the Franklinite ore, carefully separate from a portion of the sample the mineral constituents contained in the same, and analyze the separated minerals. Several analyses of average samples were then made, and from these, and the analysis of the separated minerals, the mineralogical constitution of the ores was calculated.

The complete analyses of the average samples were as follows:

	A	*B.*	*C.*	*D.*
Silica	11.85	11.59	8.64	10.70
Oxide of zinc	34.13	40.83	34.70	33.09
Proto-sesqui-oxide of iron	28.48	29.94	28.34	31.05
Alumina	0.58	trace.	trace.	trace.
Protoxide of manganese	14.13	8.35	15.50	15.51
Lime	5.51	4.16	5.70	4.59
Magnesia	0.13	0.79	1.44	0.27
Carbonic acid	4.96	4.12	6.26	4.38
Copper	0.07	undetermined.	trace.	trace.
	99.84	99.78	100.58	99.59

The analysis of the constituent minerals gave the following figures, as representative of their constitution, after separating and cleaning them from adhering gangue, etc., under a magnifying glass:

	A. Franklinite.	*B. Zincite.*	*C. Willemite Residue.*
Silica, and insoluble matter	2.62	0.81	24.36
Oxide of zinc	21.60	95.23	48.06
Proto-sesqui-oxide of iron	55.80	trace.	1.97
Alumina	trace.	trace.	....
Protoxide of manganese	17.06	3.51	12.25
Lime	1.28	0.32	6.29
Magnesia	0.30	0.10	0.99
Carbonic acid	1.35	0.37	6.28
Copper	none.	undetermined.	trace.
	100.04	100.34	100.20

The Franklinite, after deducting foreign constituents, such as silica, magnesia, lime, etc., would have the following composition: oxide of zinc, 22.90, protoxide of manganese, 18.08, and proto-sesqui-oxide of iron, 59.15. The Zincite, allowing for the impurities which even careful picking could not separate, would have the following constitution: oxide of zinc, 96.44, protoxide of manganese, 3.55, proto-sesqui-oxide of iron, a trace.

The Willemite analyzed evidently contained considerable limestone and impurities, and although the analysis is stated, it was thought safer to take the composition of Willemite as given by Dana, in calculating the mineralogical constituents of the ore.

Taking the analysis of sample marked "A," considering the constitution of the Franklinite and Zincite as determined, and using the mechanical separation marked "A," we would have the following as the mineralogical composition of the sample:

Zincite.		*Franklinite.*		*Willemite (Dana).*	
ZnO	96.44		22.90		72.90 per cent.
MnO	3.55		18.08	SiO_2	27.10 "
Fe_3O_4			59.15		

Mechanical separation of 1,700 ton sample gave:

Franklinite	48.2
Zincite	2.7
Silicates and Carbonates	49.1

48.2 per cent Franklinite = 11.04 per cent. ZnO.
2.7 " Zincite . . = 2.60 " "

13.64

Analysis of Sample "A" gives:

ZnO 34.13
ZnO for F. and Z 13.64

20.49 per cent. for Willemite:

which will require 7.617 per cent. of SiO_2 and correspond to 28.107 of Willemite.

SiO_2 in 1,700 ton sample = 11.850
" for ZnO ..... = 7.617

" " MnO and Al_2O_3 4.233
SiO_2 for Al_2O_3, etc ..... 0.340 per cent.

3.893 = Balance SiO_2.
Which would require ..... 4.589 per cent. of MnO.

8.482 per cent. of Rhodonite.

Willemite=	28.107	
Rhodonite=	8.482	
Silicate of Alumina, etc.=	0.920	
Total Silicate.....	37.509	
Carb. of CaO & MgO..	10.110	(by analysis.)
Total Silicates and Carbonates....	47.619	
Found by Wendt.....	49.100	
Difference=	1.481	
Carb. of Manganese, calculated from excess of Carbonic Acid.....	1.270	
		.211=Cu, etc.

STATEMENT.

	SiO_2.	ZnO.	Fe_3O_4.	MnO.	Al_2O_3.	CO_2.	CaO & MgO.	Calculated
Franklinite.....	----	11.04	28.51	8.71	---	---	---	48.200
Willemite.....	7.617	20.49	----	---	---	---	---	28.107
Silicate of Alumina, etc	0.340	----	----	---	0.58	---	---	0.920
Red Oxide.....	----	2.60	----	0.10	---	---	---	2.700
Rhodonite	3.893	----	----	4.589	---	---	---	8.482
Carb. of Manganese	----	----	----	0.78	---	0.49	---	1.270
Limestone	----	----	----	---	---	4.47	5.64	10.110
Copper, etc.....	----	----	----	---	---	---	---	0.211
Totals	11.850	34.13	28.51	14.179	0.58	4.96	5.64	100.000
Found by Analysis.....	11.85	34.13	28.48	14.13	0.58	4.96	5.64	99.77

To check this calculation, the average composition of Franklinite, Willemite and Zincite, as given by Dana, were used in connection with the mechanical separation already referred to, and the following calculation made as to the composition of Sample " A."

Zincite.		*Franklinite.*		*Willemite.*	
ZnO.....	95.20	ZnO.....	20.72	ZnO.....	69.97
MnO.....	3.19	MnO.....	12.72	MnO.....	1.14
		Fe_3O_4.....	63.90	Fe_3O_4.	trace
				SiO_2.....	26.81

Mechanical separation gave.....	Franklinite....	48.2
	Zincite.... ..	2.7
	Silicates and Carbonates	49.1

48.2 per cent. Franklinite= 9.99 per cent. ZnO.
2.7 per cent. Zincite= 2.57 " "

12.56 " "

Total ZnO in sample= 34.13
12.56

21.57 per cent. ZnO due to Willemite.
8.27 SiO_2.

30.84 per cent. Silicate of Zinc

Total SiO_2 in sample= 11.85
8.27

3.58 per cent. SiO_2 due to Rhodonite.
4.22 per cent. MnO.

7.80 per cent. Rhodonite.

By analysis.....		10.11 per cent. Limestone.
Carb. Manganese for excess CO_2.....		1.27
Franklinite.....	48.2	
Zincite.....	2.7	
Willemite	30.84	=38.64 Silicates.
Rhodonite	7.80	
Limestone	10.11	=11.38 Carbonates.
Carb. Manganese.....	1.27	
	100.92	50.02 per cent. Silicates and Carbonates.

Other methods of calculation were employed, such as applying the various standard analyses of Franklinite to the complete analysis given, considering that all the iron found came from the Franklinite, and using that as a starting point. For instance, taking an analysis of Franklinite as given by Cook, and applying it to complete analysis marked "D," we should obtain the following calculation and results:

The analysis of Franklinite gives sesqui-oxide of iron, 62.36—equivalent to proto-sesqui-oxide, 60.28; oxide of zinc, 22.95; protoxide of manganese, 17.20. Taking the proto-sesqui-oxide of iron in the sample at 31.05, and comparing with the proto-sesqui-oxide of iron in 100 parts, as found in the Franklinite, the amount of Franklinite corresponding to 31.05 is easily obtained. Calculating the silicate of manganese as rhodonite, taking all the oxide of zinc necessary for

silica, etc., and calling what remains red oxide, we would have the approximate mineralogical composition of Sample "D":

Franklinite	51.51
Red Oxide of Zinc	6.40
Rhodonite	11.13
Willemite	20.23
Carbonate of Manganese	1.24
Limestone	8.76
	99.27

The next trial made was to determine some solvent which would dissolve the red oxide of zinc, and practically leave the other mineral constituents, with the exception of the limestone, unacted on.

The experiments made by Prof. H. Carrington Bolton, of Trinity College, with organic acids, upon minerals, suggested to me the use of an organic acid for the quantitative estimation of the red oxide. Citric acid was first employed, but without satisfactory results; and, after several experiments, acetic acid was adopted as the best solvent obtainable.

The first step was to determine the solubility of Franklinite, Zincite, Willemite, Rhodonite, etc., in acetic acid, and a number of experiments were made with this object, the results being as follows:

Solubility of Franklinite.

Specimen.	Locality.	Amount Dissolved.
No. 1	Franklinite (analyzed)	5.42 per cent.
No. 2	Mine Hill	2.63 "
No. 3	Mine Hill	1.45 "
No. 4	Crystals	0.57 "
Average		2.52 "

Time 1 hr. 30 min. 50 per cent. acid; 50 per cent. water.

Solubility of Red Oxide.

Dark Red—Entirely soluble.
Light Red—*Slight* residue reacting for Manganese.

Solubility of Rhodonite.

Specimen.	Locality.	Amount Dissolved.
No. 1	Mine Hill	1.66 per cent.
No. 2	Sterling	2.33 "
No. 3	Franklin	1.03 "
No. 4	Mine Hill	2.18 "
Average		1.80 "

Time 1 hr. 30 min. 50 per cent. acid; 50 per cent. water.

Solubility of Willemite.

Specimen.	Locality.	Amount Dissolved.
No. 1	Mine Hill	22.53 per cent.
No. 2	Franklin	32.23 "
No. 3	Mine Hill	28.43 "
No. 4	Franklin	34.08 "
Average		29.32 "

Time 1 hr. 30 min. 50 per cent. acid ; 50 per cent. water.

Comparing these various solubilities, we arrive at the following conclusions:

1st. That *Franklinite*, if pure, is practically insoluble.

2d. That *Red Oxide of Zinc* is entirely soluble.

3d. That *Rhodonite* is slightly soluble.

4th. That *Willemite* is partially soluble.

5th. That the *Carbonates*, etc., are almost totally soluble. Therefore in the solution from the treatment with acetic acid, there would be: silica, from the Willemite and Silicate of Manganese, oxide of manganese, in small quantities, and oxide of zinc, from the Red Oxide and Willemite, provided a definite method of treatment be adopted, and all contact with the acid be avoided, as soon as examination shows that the red particles in the ore are dissolved.

The following method of analysis was therefore adhered to:

A. *Sampling.*—Crushing and quartering through three successive stages, until the sample was sufficiently fine for analysis.

B. *Method.*—Weigh out two grms. and treat with a mixture of acetic acid and water (fifty per cent. No. 8 acetic acid, and fifty per cent. of water). Allow to stand approximately one and one-half hours, examining occasionally under a powerful magnifying glass; heat gently, if any red particles are visible, and continue the treatment until no red oxide is contained in the residue. Filter and wash.

Residue A.

Dry and weigh on weighed filter.

Solution A.

Acidify with HCl, and evaporate to dryness; take up with HCl and water; warm, filter and wash.

Residue B.

Silica—dry, ignite and weigh.

Solution B.

Neutralize with Na_2CO_3, acidify with acetic acid, and precipitate with H_2S gas.

Solution C.

Boil with $KClO_3$, to oxidize sulphur. Neutralize carefully and precipitate Manganese with Br water as usual. Filter and wash, diss. in HCl, and re-precipitate with Na_2CO_3.

Ignite and weigh Mn_3O_4.

Precipitate C.

Wash with H_2S water, diss. in HCl, oxidize sulphur, re-precipitate with Na_2CO_3. Dry, ignite and weigh the *ZnO*.

Results. -1st. Residue insoluble in acetic acid.
2d. Silica in acetic acid solution.
3d. ZnO dissolved by acetic acid.
4th. MnO_2 dissolved by acetic acid.
Undetermined; CaO and MgO dissolved.

Taking into consideration the previous determinations of the solubilities of the Silicates of Zinc and Manganese, etc., we have the following data:

Ratio of Solubilities.—29.32 (solubility of Willemite) is to 1.80 (solubility of Rhodonite) as 16.5 is to 1.

Ratio of Silica in these minerals (Dana), 27 to 46. Occurrence of these minerals by supposition in these ores, 1 to 1. Multiplying these ratios together we have 445.5 to 46. Hence, approximately 90.64 per cent. of the silica *in solution* will be due to the Willemite, and 9.36 per cent. to the Rhodonite—say 9-10 and 1-10. Applying this method and adopting this basis of calculation, I obtained the following results from a series of analyses made on ten different samples:

	1	2	3	4	5
Residue	78.35	74.81	79.86	80 17	80.86
Silica	1.82	2.39	2.71	1 80	1.71
Oxide Zinc	8.66	8.14	7.77	11 29	11.63
Oxide Manganese	3.32	2.83	3.46	3.13	2.71
Oxide Zinc for Silica	4.42	5.80	6.58	4.37	4.15
Oxide Zinc for Red Oxide	4.24	2.34	1.19	6.92	7.48
Red Oxide	4.42	2 43	1.24	7.23	7.79

	6	7	8	9	10	*Average*
Residue	80.22	74.76	75.31	72 97	70.86	78 042
Silica	2.34	2.74	2.31	3.86	2.33	2.227
Oxide Zinc	12.56	11.59	14.57	11.42	11 99	10.778
Oxide Manganese	3.76	3.29	3.06	....	3.22	3.185
Oxide Zinc for Silica	5 68	6 65	5.61	9.38	5.66	5.407
Oxide Zinc for RedOxide	6.88	4.94	8.96	2.04	6.33	5.370
Red Oxide	7.16	5.14	9.33	2.13	6.59	5.593

Other experiments and analyses were made, and the basis of calculation changed by allowing 75 per cent. of the silica found in solution for the Willemite. The red oxide might also be slightly raised by adding some of the manganese found in solution, the amount to be added being calculated by comparison with the analysis of Zincite already given. Rhodonite has been taken as the silicate of manganese found in these ores, instead of Tephroite, although the latter occurs to some extent—the ratio of occurrence of the Willemite and Rhodonite assumed, *i. e.*, 1 to 1, being thought to more than compensate for any silicate of manganese which might go into solution from the presence of Tephroite. This mineral is somewhat more soluble in acetic acid than Rhodonite, and some allowance should, therefore be made for its possible occurrence.

The foregoing method, owing to slight variations in solubility, may not be accepted as an exact analytical process, but it undoubtedly gives, within close limits, the red oxide of zinc in the sample treated, provided that proper care be taken in the analysis that the ore is not too finely pulverized, and that the treatment with acid is stopped at the point where the last trace of red disappears.

Of course, if this latter be continued beyond this point, or the ore be too fine, more silicates will be dissolved than is absolutely necessary, and the error in calculating will be increased, the results being proportionally incorrect.

DISCUSSION.

Mr. A. H. ELLIOTT enquired concerning the condition in which the copper probably existed.

Mr. N. H. DARTON stated his observation of the occurrence of silicate of copper at Franklin; and that Dr. Hayes had established by microscopic examination that the color of red oxide of zinc was due entirely to disseminated scales of specular oxide of iron.

Mr. JULIEN remarked on the importance of the discovery of the complete solubility of the red oxide of zinc in acetic acid. The purity of the minerals used in the analyses might have been ensured by previous microscopic examination, all but the Franklinite being translucent in thin section. The variation in the recorded analyses of Willemite, etc., may be largely due to the absence of this precaution. The proportion of the minerals present in the ore might have been ascertained in the fine powder, by microscopic examination. It was a question whether both the alumina and oxide of copper may not have existed in replacement of oxides of iron and zinc. Dependence upon the inexactly defined ratio of solubilities seemed of doubtful value for the determination of the proportion of Willemite and Rhodonite, the

quantities of these minerals in the powder under treatment being unequal.

Dr. RICKETTS replied that the investigations in which he had been engaged were entirely of a practical nature, in which an accuracy within one-fourth to one-half per cent. was aimed at, and for this the use of a powerful magnifying glass was sufficient. The determination of the condition of the alumina and copper was not essential for his purpose; both probably existed as silicates. The method founded on the solubilities of certain minerals had been found practically useful, closely agreeing with the general run of analyses. The pure zincite was considered the dark red mineral, colored by oxides of manganese and iron, and its average amount in the ores of Franklin had been determined and admitted as about six per cent.

The CHAIRMAN remarked on the intricacy of the problem, which had been the subject of this investigation, and on the interesting and suggestive solution which had been presented: the recognition of the proportion of so large a number of minerals as occur in this ore being extraordinarily accurate.

November 20, 1882.

LECTURE EVENING.

The President, Dr. J. S. NEWBERRY, in the Chair.

The large Hall was filled to overflowing.

The following letter from Prof. J. K. REES, Director of the Observatory of Columbia College was read:

(Abstract.)

"I beg leave to call the attention of those members of the Academy possessing telescopes to the grand sunspot on the western portion of the sun. Many of them have seen notices of this spot in the daily papers. It deserves especial study in connection with the late displays of auroras and the great electric storm, also as throwing some light on the connection of comets and sunspots. This spot I have seen at noon, and at four o'clock without a telescope, by protecting the eye with colored glass. I saw it once without any protection to the eye, by looking through a narrow slit formed by my fingers.

The great spot is really made up of several mutually encroaching spots. Three nuclei are very well defined, and out into the darkest one protrudes a penumbral finger.

The disturbed region about this spot is about 80,000 miles square, or covering 6,400,000,000 square miles.

There are four other spots on the sun, three near the center of the

sun of quite small size, and a fourth near the eastern limb, consisting really of a group of three conjoined."

The PRESIDENT referred to the death this morning, from acute disease, of a resident member of the Academy, Dr. HENRY W. DRAPER, at the age of 45—a great loss to science—and to his distinguished researches and labors in celestial physics.

The lecture of the evening was delivered by Rev. HORACE C. HOVEY, of Fair Haven, Conn., on the subject of—

SUBTERRANEAN SCENERY.

(Abstract.)

An impression prevails that having seen one cave you have seen all caves. As well might you say that, having seen one hill you have seen all hills, or that, having seen one cataract, you have seen all cataracts. There is variety in the subterranean world, almost as great and striking as that encountered in the surface-region men are more familiar with. Just as there are prairies and table-lands without the semblance of a hill, so there are broad areas of non-cavernous rocks; and indeed only a limited portion of the globe is favorable to the formation of large cavities beneath its crust. The causes producing those that exist are as unlike and distinct as those carving the contour of the mountains.

Volcanic agencies are conspicuous in undermining the earth. Examples of flaming caves, like those in the mountains of Cumana, are due to the fires of still active volcanoes. Caves of great size and beauty are sometimes caused in beds of lava by the over-lapping of the fiery torrent, or by the sinking away of a portion of the fluid mass from the cooling crust—in either case leaving walls lined with blister-holes and lava-froth. Iceland claims the finest of known lava caves, adorned with superb black icicles of obsidian, rivaling in beauty the rarest zeolites.

Marine caves differ materially from those formed by volcanic causes. They are found wherever the swell and lash of the billows have excavated rocks too hard to be wholly displaced by their action. Long galleries join each other in bold and grotesque arches, whose walls are polished by the waves and painted by the sea-water. At low tide it is often as if one were walking at the bottom of a deep sea, and examining objects ordinarily brought to view only by dredging. Here and there one encounters deep pools where fishes swim; while in shallower waters are star-fishes, sea-urchins, and sea-anemones, under a vaulted roof decked by a living tapestry.

A celebrated example of marine caves is the Grotto Azuro, in the

Island of Capri, where the walls, the stalactites and every object is tinted blue by the rays reflected from the brilliant skies of Italy.

Fingal's Cave, and others in the basaltic district around the Island of Staffa, may probably be ascribed to a combination of causes, of which oceanic violence was but one. The broken ends of columns, above which rise lofty ranges of those that are entire, the plash of the waves, the play of colors in the soft twilight that fills the cave, and the tall gothic archway with its archæological suggestions, have been repeatedly described.

Probably the most exquisite grottoes in the world are the ice-caves occasionally formed in the heart of glaciers, and also, in severe winters, under great cataracts, such as Niagara Falls.

Beauty of a far different sort characterizes some of the caves in tropical regions ; for example, that of Cacahuamilpa in Mexico, and the cave of the Guacharo, in South America. You enter the abyss through a luxuriant grove, and find the vegetation continuing far under ground. Pale plants lift their blanched stalks amid sparry growths, while the oil-birds flit through the mazes of subterranean shrubs and vines.

Some of the most noted caverns are hardly worth describing so far as their scenery is concerned ; for the reason that their fame is due to the quantities of old bones that encumber the floor and lie buried in the dripstone. Of these the cave of Gailenreuth, whence were exhumed the remains of 800 gigantic bears, may serve as a specimen.

Contrasted with bone caves is the elaborate temple-cave of Elaphanta, whose chambers of imagery are guarded by colossal figures. The views exhibited of this cavern were taken a few months ago for the Rev. Joseph Cook, by whose permission lantern-slides have been prepared for this occasion.

As has often been remarked, marine caves are usually of little depth. "Along the whole Atlantic coast", observes Prof. N. S. Shaler, "from Nova Scotia to Mexico, I do not know of a single cavern deep enough to give darkness, and above the present level of the sea. The existence of deep caverns is a sign that the region has long been above the sea."

Hence, he who would explore those vast labyrinths, where one may wander on for miles, must forsake the sea-board for the interior.

One reason for this is purely lithological. The rocks along the Atlantic sea-coast are usually quite heterogeneous, and are split by fissures and crossed by veins, so that a cave could not extend very far into them, without destroying itself. This, indeed, is sometimes done in regions remote from the sea. An instance may be seen at Madison, Indiana, where thin strata of the Lower Silurian are overlaid by thick strata of the Upper. Grottoes are here washed out by the removal of

the softer material, leaving the harder ledges above. After a while the weight of the over-hanging mass causes it to fall. Thus valleys are made with precipitous sides and encumbered by rocky debris. Thus also natural bridges are left, like that famous one in Rockbridge County, Virginia, which is but a remnant of the roof that once over-arched the valley.

The homogeneity of the limestones of the Ohio Valley is extremely favorable for the formation of extensive caverns. It is estimated that there are 8000 square miles of cavernous limestone in Kentucky alone. I remember seeing, in a marble quarry in that region, a block without a flaw, 150 feet long by 30 feet square, cut simply to show what could be done.

The thickness of the sub-carboniferous limestone, from which Mammoth and Wyandot Caves are excavated, varies from 100 to 1,000 feet. This makes possible the formation of long, winding avenues, with here and there extraordinary enlargements, spacious halls, deep pits and lofty domes, cutting through all galleries from the surface down to the drainage level.

The Virginia caves, on the other hand, of which Luray Cave is the noblest specimen, are examples of excavations from rock tilted and fractured by upheavals, the resulting seams having often been afterwards filled with crystalline material. Hence, instead of well defined arcades, and symmetrical halls and domes, there are extremely irregular rooms, adorned with such a profusion of stalactitic ornamentation, that in Luray Cavern, there seems to be hardly a square yard left bare showing the naked rock!

Subterranean scenery is also effected by various mineralogical modifications. The sharp, glassy needles of obsidian, in the lava cave of Surtsheller, differ greatly from the snowy embellishments found in the Grotto of Antiparos, carved from statuary marble. And again, the majestic columns of basalt, that guard Fingal's Cave, strike the eye differently from the frowning arches of the granite caves of Norway or of Maine.

Certain metallic ores may stain the cavern walls red, yellow, blue or black. And when this incrustation is broken through by the efflorescence of the shining white crystals of the sulphate of lime, of magnesia, or of soda, remarkable effects are produced.

Gigantic silhouettes seem to be cut from the ceiling of creamy limestone; grotesque forms start out from the darkness; grim spectres seem to wave their shadowy arms. These illusions are purely mineralogical. A strangely beautiful example of such transformations may be seen in the so-called Star Chamber of Mammoth Cave; where the gray walls support a lofty ceiling coated with the black oxide of man-

ganese, which is studded with thousands of white spots caused by the efflorescence of the sulphate of magnesia.

Cleveland's Cabinet, in the same cave, is a very treasure house of alabaster brilliants. Imagine symmetrical arches of fifty feet span, where the fancy is at once enlivened and bewildered by a mimicry of every flower that grows. Similar crystalline conservatories are to be seen in other parts of Mammoth Cave, and also in Wyandot and other Western caves.

Earthquakes have had comparatively little to do with subterranean scenery, though generally credited with having wrought many changes. Among possible effects of earthquake shocks one of the most remarkable is the dislodgment of huge masses of dripstone in Luray cavern; upon which new formations have since grown, whose brilliant white contrasts vividly with the rusty red or rich bronze of the more ancient deposit. Examples of this fresh formation are Titania's Vail, the Empress Column, and Brand's Cascade. The Fallen Column, twenty-one feet long and twelve feet thick, has been regarded as cast down by an earthquake shock. It was evidently wrenched away at some remote period from its point of attachment above, and fell swaying to and fro.

Most of the variations in subterranean scenery, usually ascribed to earthquakes, are really due to the chemical and mechanical action of water. Acidulated water cuts into the limestone, searching out the lines of weakness, until channels are made leading down to some subterranean outlet. The agency of running streams carries on the work begun by water freighted with carbonic acid. Sand and gravel borne in with these streams make of them powerful cutting-engines.

Thus may be explained the huge pits and domes of Mammoth Cave; and in the same way the deep chasm known as Pluto's Ravine, in Luray Cave. To the same cause I attribute the dislodgment of the Fallen Column and other great stalactites in the latter cavern. My theory is that Luray Cave was first hollowed out by acidulated water; then it was partly filled by dripstone; then the outlet was stopped and the entire cavern flooded with strongly acidulated water, whereby the first set of stalactites was partly destroyed; and when the outlet was re-opened, or a new one found, then came the catastrophe that hurled mighty masses down and left them as proofs that water may be as energetic as fire. And finally the fresh set of stalactites was created, out of the already refined materials, by the beauty of which the eyes of the civilized world have been attracted.

The scenery of certain caves is modified by the presence of considerable bodies of running or standing water. Echo River, in Mammoth Cave, is about three-quarters of a mile long, from 20 to 200 feet wide,

and from 10 to 40 feet deep. The "Dead Sea," "Lake Lethe" and the "River Styx," are smaller bodies in the same cave. These all have secret communication with the adjacent Green River, and are liable to sudden floods, sometimes rising 60 feet, and one result is the deposit of immense mud-banks. (It is aside from the purpose of this paper to describe the living objects found in these waters, or the remarkable acoustic properties of Echo River passage-way.)

Agreeably contrasted with these dismal lakes are the exquisitely clear pools occupying the crystal basins of Luray Cavern. These build their own walls, by the process of crystallization, till some of them are more than five feet high and enclose lakes fifty feet across. There are more than a hundred of them in this cave, as clear as ether, and holding their unruffled surface as a mirror to reflect the countless stalactites hanging above them. By as careful an estimate as could be conveniently made, the Imperial Spring is adorned by 48,000 such stalactites! The "Castles on the Rhine" are but the incrusted stalagmites remaining where one of these pools once lay, but whose waters have long ago been drained.

Stalactites and stalagmites are referred to in every description of cavern scenery, and their causes are well understood. The carbonate of lime left by the water, on evaporation, makes a ring on the ceiling, followed by ring after ring, till a cylinder grows that finally is thickened into an elongated cone; and this is a stalactite. The deposit on the floor is a thin film, which by repeated coating grows into the blunt stalagmite. The two are often united into a column. The Pillar of the Constitution, in Wyandot Cave, is one of the largest known stalacto-stalagmitic columns, being 40 feet high and 25 feet thick, and homogeneous throughout. The material is Oriental alabaster (to be distinguished from the softer gypsum, being a very hard carbonate of lime), and this stately pillar was once resorted to by the Indians as a quarry for materials from which to make amulets and images. Some of the stalactites in Luray Cavern are 50 feet long; and the Double Column, composed of two consolidated stalagmites, rises to the height of perhaps sixty feet above the floor. Stalactites sometimes are blade-like and highly sonorous. Again they hang like scarfs or shawls, pure white or striated: many fine examples of which are found in Luray. Stalactitic distortion is quite a study in itself. Among assignable causes are the growth of fungi, the influence of atmospheric currents, and the outgrowth of lateral crystals.

The lantern views of Subterranean Scenery represent Fingal's Cave, the Cavern-Temple of Elephanta, the Ice Caves of Niagara, the Bone Cave of Gailenreuth, and several other miscellaneous selections; but the great majority of them were taken from scenes in Wyandot, Mam-

moth and Luray caverns, and were made expressly for this exhibition.

The efforts of Mr. Charles Waldach to take photographs by aid of magnesium light resulted in a number of interesting pictures of localities in Mammoth Cave. His magnesium alone cost him $500. But for practical use these photographs were not found so desirable as a series of sketches, made in black and white, under my supervision, by Mr. J. Barton Smith. This artist also made the sketches from Wyandot Cave. These were prepared for the lantern by Mr. J. M. Blake, of New Haven. The advantages for taking views in Luray Cavern were superior, since it was lighted by a series of electric lamps placed at the most interesting localities. The thirty-six lantern views now shown to illustrate Luray Cave, were taken and prepared by Mr. C. H. James, of Philadelphia. Special mention should be made of Col. Francis Klett, manager of Mammoth Cave, and Mr. R. R. Corson, manager of Luray Cavern, by whom every needed facility was cheerfully given for obtaining the facts of a scientific nature sought, and also the pictorial representations exhibited of subterranean scenery.

At the close of the lecture a resolution was passed, conveying thanks to Mr. Hovey, for his very interesting and instructive lecture.

November 27, 1882.

The President, Dr. J. S. Newberry, in the Chair.

The audience filled the large hall.

A lecture was delivered by Dr. J. S. Phene, of London, England, illustrated with a large number of diagram views, and entitled:

RECENT ARCHÆOLOGICAL DISCOVERIES RELATING TO THE MOUND-BUILDERS.

At the close of the lecture the President remarked that the geological evidence rendered it by no means impossible that the theory of the lecturer might be well founded, of the contemporaneous existence of the mound-building race with the ancient horse, whose remains, exactly like those of the modern horse, have been found in deposits of very recent age in Oregon, etc., and with an-

imals of the elephant family, whose remains, (both the elephant and mastodon) occur abundantly in many quaternary deposits. As to the camel, there is less evidence, but no impossibility of its existence at the same time.

A resolution of thanks to Dr. PHENE, for his interesting lecture, was passed, and, on motion, Dr. PHENE was nominated and unanimously elected Corresponding Member of the N. Y. ACADEMY OF SCIENCES.

December 4, 1882.

REGULAR BUSINESS MEETING.

The President, Dr. J. S. NEWBERRY, in the Chair.

Thirty-two persons present.

The following persons were elected:

Resident Member, ISIDORE OSORIO.

Corresponding Member, Dr. HENRY R. ROGERS, of Dunkirk, N. Y.

Honorary Member, Sir HENRY CRESWICKE RAWLINSON, LL.D.

The resignation of the following members, on account of removal from the city, etc., were accepted:

I. DEVLIN,	C. HEITZMAN,
R. DUNLAP,	A. A. REDFIELD,
Q. A. GILLMORE,	I. H. STEBBINS, JR.,

W. H. VAN ARSDALE.

Mr. G. F. KUNZ exhibited a specimen of topaz from the new locality at Stoneham, Me., as the finest ever found in America; also a number of smaller crystals of the same, all full of fluid cavities, and some showing a curious iridescence when looked upon from one direction, *i.e.*, from the O plane; also crystals of monazite from the same locality, there associated with albite, columbite, triphyllite, etc.; also a fine crystal of chrysoberyl from Brazil, a crystal of andalusite, and a catseye.

Prof. EGLESTON pronounced the topaz crystal as certainly the largest ever found on the continent, its iridescence being due to fine lines produced by the easy cleavage parallel to the base. The crystals of chrysoberyl were now very uncommon, though such

were not rare 25 to 30 years ago. The crystal of andalusite presented faces and distortion which were novel and well worth description in detail.

A paper was then read by Mr. WILLIAM L. LAY,

ON THE DEPOSITS OF EARTH-WAX (OZOKERITE) IN EUROPE AND AMERICA.

(Abstract).

There exists a large mining and manufacturing industry in Austria, that of ozokerite, or earth-wax—which has nothing like it in any other part of the known world, an industry that supplies Europe with a part of its beeswax, without the aid of the bees. It may not be generally known that the mining of petroleum was a profitable industry in Austria long before it was in this country. In 1852, a druggist near Tarnow distilled the oil and had an exhibit of it in the first World's Fair in London. In America the first borings were made in 1859. Indeed, the use of petroleum as an illuminator was common at a very early age in the world's history. In Persia at Baku, in India on the Irawada, also in the Crimea, and on the river Kuban in Russia, petroleum has been used in lamps for thousands of years. At Baku the fire worshippers have a never-ceasing flame, which has burned from time immemorial. The mines of ozokerite are located in Austrian Poland, now known as Galicia. Near the city of Drohabich, on the railway line running from Cracow to Lemberg, is a town of six thousand inhabitants, called Borislau, which is entirely supported by the ozokerite industry. It lies at the foot of the Carpathian Mountains. About the year 1862, a shaft was sunk for petroleum at that place. After descending about one hundred and eighty feet, the miners found all the cracks in the clay or rock filled with a brown substance, resembling beeswax. At first, the layers were not thicker than writing paper ; but they grew thicker gradually below, until at a depth of three hundred feet they attained a thickness of three or four inches. Upon examination, it was found that a yellow wax could be made of a portion of this substance, and at once a substitute for wax was manufactured.

The discovery caused an excitement like the oil fever of 1865, in America. A large number of leases were made. When I saw the wells of Pennsylvania, in 1879, there were more than two thousand. The owner of the land received one-fourth of the product and the miners three-fourths. In the petroleum region, the leases at first were whole farms, then they were reduced to 20, then 10, then five, and at last to one acre, which is a square of 209 feet.

But in the ozokerite region of Poland, where everything is done on a

small scale, when compared with like enterprises in this country, the leases were on tracts thirty-two feet square. These were so small that the surface was not large enough to contain the earth that had to be raised to sink the shaft; consequently the earth had to be transported to a distance, and, when I saw it, there was a mound sixty or seventy feet high. Its weight had become so great that it caused a sinking of the earth, and endangered the shafts to such an extent that the Government ordered its removal to a distance and its deposit on ground that was not undermined. The shafts are four feet square, and the sides are supported by timbers six inches through, which leaves a shaft three feet square. The miner digs the well or shaft just as we dig our water wells, and the dirt and rock is hoisted up in a bucket by a rope and windlass. But one man can work in the shaft at a time. For many years no water was found; but, as there is a deposit of petroleum under the ozokerite, at a depth of six hundred feet from the surface, the miners were troubled with gas. This is got rid of by blowing a current of fresh air from a rotary fan, through a pipe extending down the shaft as fast as the curbing of timber is put in place. The ozokerite is imbedded in a very stiff blue clay for a depth of several hundred feet; bolow, it is interlaid with rock. [Specimens of crude and manufactured ozokerite were on exhibition, through the kindness of Dr. J. S. Newberry].

That part of the earth's surface has more miners' shafts to the acre than any other part of the globe. As wages are very low in Poland, averaging not more than forty cents a day for men and ten cents for children, a very small quantity of ozokerite pays for the working. If thirty or forty pounds a day is obtained, it remunerates the two men and one or two children required to work each lease. When the bucket, containing the earth, rock and wax, is dumped in the little shed covering the shaft, it is picked over by the children, who detach the wax from the clay or rock with knives. The miners use galvanized wire ropes and wooden buckets. When preparing to descend, they invariably cross themselves and utter a short prayer. The business is not free from danger, carelessness on the part of the boy supplying the fresh air, or the caving in of the unsupported roof, causing a large number of deaths. One of the Government inspectors of the mines informed me that in one week there had been eight deaths from accidents.

The ozokerite is taken to a crude furnace, and put into a common cast-iron kettle, and melted. This allows the dirt to sink to the bottom, and the ozokerite, freed from all other solids, is skimmed off with a ladle, poured into conical moulds, and allowed to cool, in which form it is sold to the refiners, for about six cents per

pound. The quantity produced is uncertain, as the miners take care to understate it, for the reason that the Government lays a tax upon all incomes, and the landowner demands his one-fourth of the quantity mined. The best authority is Leo Strippelman, who states the quantity produced in fifteen years at from 375,000,000 to 400,000,000 pounds, worth twenty-four millions of dollars. As the owners of the land get one-fourth of the sum, they received six millions. This is at the rate of four hundred thousand a year, a rather valuable crop from some two hundred acres of land.

The miners do not support the earth by timber or pillars, as they should; the result is that the whole plot of about two hundred acres is gradually sinking, and this will eventually ruin the industry in that part of the deposit. In another part of the same field, a French company has purchased forty acres, and it is mining the whole tract and hoisting through one shaft by steam power. In that shaft they have sunk to a depth of six hundred feet, and are troubled with water and petroleum. These they pump out very much the same way as in coal and other mines, worked in a scientific manner. The thickest layer of ozokerite found is about eighteen inches, and this layer or pocket was a great curiosity. When first removed at the bottom of the shaft, it was found to be so soft that it was shovelled out like putty. During the night it oozed into the space that had been emptied the day before; this continued for weeks, or until the pressure of the gas had become too weak to force it out.

I have been occupied in the petroleum region of Pennsylvania since 1860, have seen all the wonderful development of the oil wells, and was very much interested in contrasting the Austrian ozokerite and petroleum industry with the American. It is a good illustration of the difference between the lower class of Poles and Jews and the Yankee. Borislau, after twenty years work, was unimproved, dirty, squalid and brutal. It contained one school house, but no church nor printing office. None of its streets were paved, and, in the main road through the town, the mud came up to the hubs of the wagon wheels for over a mile of its length. In places, plank had to be set up on edge to keep the mud out of the houses, which were lower than the road. It contained numerous shops, where potato whiskey was sold to men, women and children. It depends on a dirty, muddy creek for its supply of water. Its houses were generally one-story, built of logs and mud.

On the other hand, Oil City, a town of the same age and size, contained eight school houses (one a high school building), twelve churches, and two printing offices. It has paved streets, which, in 1863, were as deep with mud as that in Borislau, in 1879. It has no whiskey shops where women and children can drink. Many of its houses are of brick,

two, three, four and five-stories high. Its water-works cost one hundred and fifty thousand dollars. All this has been done since 1860, when it did not contain forty houses.

I saw in the market-place of Borislau women, standing ankle deep in the mud, selling vegetables. One woman really had to build a platform of straw, on which to place a bushel of potatoes; if the straw foundation had not been there, the potatoes would have sunk out of sight. Borislau is three miles from Drohobich, a city of thirty thousand inhabitants; between the two places, in wet weather, the road was impassable. For a third of the way, it was in the bed of the creek; and I had to wait a day for the water to fall so as to navigate it in a wagon. On enquiring why they did not improve the road, I found the same difficulty as the Arkansas settler encountered with his leaky roof; when it rained he could not repair it, and when it was dry it did not need repair: so with the road to Borislau.

Ozokerite (from the Greek words, "Ozein," to smell and "Keros," wax), is found in Turkistan, East of the Caspian Sea—in the Caucasian Mountains, in Russia—in the Carpathian Mountains, in Austria—in the Appenines, in Italy—in Texas, California, and in the Wasatch Mountains, in the United States. Commercially, it is not worked anywhere but in Austria; although, I believe, we have in Utah a larger deposit than in any other place. I made two journeys to examine the deposits in the Wasatch Mountains. For a distance of forty miles, it crops out in many places, and on the Minnie Maud, a stream emptying into the Colorado, I found a strata of sand-rock, from ten to twelve feet thick, filled with ozokerite.

No systematic effort has been made to ascertain the quantity of ozokerite in Utah. I saw a drift of some fourteen feet, at one place, and a shaft twenty-three feet deep, at another. In this shaft, the vein was about ten inches wide; and it could be traced along the slope of the hill, for several hundred feet. The largest vein of pure ozokerite is seen on Soldiers' fork of Spanish Cañon, which enters Salt Lake Valley near the town of Provo. This vein is very much like the ozokerite of Austria, and contains between thirty and forty per cent. of white ceresin (which resembles bleached beeswax), about thirty per cent. of yellow ceresin (which resembles yellow wax), and twenty per cent. of black petroleum; the residue is dirt. Dr. J. S. Newberry, of Columbia College, and Prof. S. B. Newberry, of Cornell University, made examinations of the ozokerite found in Utah; those who are interested in the subject will find the papers published in the *Engineering and Mining Journal* for the year 1879.

A deposit of white ozokerite occurs on the top of the Apennine Mountains, in Italy, of which a specimen is here exhibited. An interest-

ing story is told of its discovery. A church at Modena was robbed; among other articles taken was a quantity of wax candles. A short time afterwards, a woman brought to a druggist a quantity of wax and offered it for sale. The druggist bought it and afterwards suspected it consisted of the stolen candles melted down. Soon afterward she brought another lot. He had her arrested. When questioned by the magistrate, she said she found the wax in the clay on her farm, about twenty miles from the city. This story confirmed him in the belief that she had stolen the candles, or was the receiver of the stolen goods; for such a thing as a deposit of wax in the soil was unheard of. She was therefore remanded to jail. On three several days, she was brought before the Court, and, when questioned, told the same story. She was a member of the church, and requested the priest to be sent for. He came, and, after an interview between them, he said it was easy to disprove her story, if it was a lie, by sending her home, in company with an officer, to investigate. The Court sent the priest, who was the only one who believed her. On coming to her house, she took her pick and shovel, and going to the place at the top of the hill, she dug out of the clay a quantity of white ozokerite, proved her case, and was at once set at liberty. She performed the same service for me, and I saw her dig the specimen and heard her tell the story as I have told it to you. The hill was composed of loose clay and stones. It appeared as if it had been forced up by gas or some power from below the surface. The quantity that could be gathered, by one person, laboring constantly for a week, was only twenty-five or thirty pounds. An attempt had been made to sink a shaft; but, at a depth of fourteen feet, the pressure of the clay was sufficient to break the boards that held up the sides. The earth caved in and the shaft was abandoned.

It is not necessary here to describe the various processes of manufacture, it will be sufficient to enumerate some of the forms of ozokerite, and the uses to which it is put. At Borislau, there are several refineries, where candles, tapers and lubricating oils are made. In Vienna, there are five factories; in one of these, they make white wax, wax candles, matches, yellow beeswax, black heel-ball, colored tapers, and crayon pencils. In Europe, large quantities of the yellow wax are used to wax the floors of the houses, many of the finer ones being waxed every day. It is a curious fact that the Catholic Church does not allow the use of paraffine, sperm or stearine candles; at the same time nearly all the candles used in the churches in Europe are made from ozokerite, which is a natural paraffine, made from petroleum in nature's laboratory. In the United States, the only uses made of ozokerite, so far as I know, are chewing gum and the adulteration of beeswax. In this the Yankee gives another illustration of the ruling

passion strong in money-making, which gives us wooden nutmegs, wooden hams, shoddy-cloth, glucose-candy, chicory-coffee, oleomargarine-butter, mineral sperm-oil made from petroleum, and beeswax made without bees.

After this paper was written, the following translation from a pamphlet, published by the First Hungarian Galician Railway Company, in 1879, came to my notice. The writer's name is not published.

"Mineral wax, in the condition in which it is taken from the shafts, is not well adapted for exportation, since it occurs with much earthy matter; and, at any rate, an expensive packing in sacks would be necessary. It is therefore first freed from all foreign substances by melting, and cooled in conical cakes of about 25 kilos. weight, and these cakes are exported. There are now, in Borislau, 25 melting works, which, in 1877, with one steam and 60 fire kettles, produced 95,000 metric centners (9,500,000 lbs.).

The melted earth-wax is sent from Borislau to almost all European countries, to be farther refined. Outside of Austro-Hungary, we may specially mention Germany, England, Italy, France, Belgium and Russia, as large purchasers of this article of commerce.

Products and their Applications.

The products of mineral wax are:

(*a.*) *Ceresine*, also called ozocerotine or refined ozokerite, a product which possesses a striking resemblance to ordinarily refined beeswax. It replaces this in almost all its uses, and, by its cheapness, is employed for many purposes for which beeswax is too dear. It is much used for wax candles, for waxing floors and for dressing linen and colored papers. Wax-crayons must be mentioned among these products. The house of Offenheim & Ziffer, in Elbeteinitz, makes them of many colors. These crayons are especially adapted to marking wood, stone and iron; also, for marking linen and paper, as well as for writing and drawing. The writings and drawings made with these crayons, can be effaced neither by water, by acids, nor by rubbing.

Concerning the technical process for the production of ceresine, it should be said that, when the industry was new (the production of ceresine has been known only about eight years, since 1874), it was controlled by patents, which are kept secret. This much is known, that the color and odor are removed by fuming sulphuric acid.

From mineral wax of good quality about 70 per cent. of white ceresine is obtained. The yellow ceresine is tinted by the addition of coloring matter (annatto).

(*b.*) *Paraffine*, a firm, white, translucent substance, without odor. It is used, chiefly, in the manufacture of candles, and also as a protec-

tion against the action of acids, and to make casks and other wooden vessels water-tight, for coating corks, etc., for air-tight wrappings, and, finally, for the preparation of tracing paper. There are several methods of obtaining paraffine from ozokerite (see the Encyclopedic Handbook of Chemistry, by Benno Karl and F. Strohmann, Vol. IV., Brunswick, 1877).

The details of the technical process consist, in every case, in the distillation of the crude material, pressure of the distillate by hydraulic presses, melting, and treating by sulphuric acid.

In the manufacture of paraffine from ozokerite, there are produced from 2 to 8 per cent. of benzine, from 15 to 20 per cent. of naphtha, 36 to 50 per cent. of paraffine, 15 to 20 per cent. of heavy oil for lubricating, and 10 to 20 per cent. of coke, as a residue.

(*c.*) *Mineral oils*, which are obtained at the same time with paraffine, and are the same as those produced from crude petroleum, described above. The process consists, as in the natural rock oils, besides the distillation, in the treatment of the incidental products with acids and alkalies.

Of the products of ozokerite, manufactured in Galicia, the greater part goes to Russia, Roumania, Turkey, Italy and Upper Hungary. The common paraffine candles made in Galicia—which are of various sizes, from 28 to 160 per kilo—are used by the Jews in all Galicia, Bukowuina, Roumania, Upper Hungary and Southern Russia, and form an important article of commerce. Ceresine is exported to all the parts of the world. Of late a considerable quantity is said to have been sent to the East Indies, where it is used in the printing of cotton."

DISCUSSION.

Mr. KUNZ enquired whether any rocksalt occurred in Galicia; as a specimen in his possession was lined with ozokerite.

Mr. LAY replied that no salt was found in that region.

The PRESIDENT stated that ozokerite was undoubtedly a product of petroleum. Little was known by the public concerning its use and value. He exhibited specimens of natural brown ozokerite, of yellow ozokerite, sold as beeswax, and of a white purified form, which had been treated by sulphuric acid. Specimens from Utah had already been shown before the Academy. There was no mystery as to its genesis in either region, as it had been shown to be the result of inspissation of a thick and viscid variety of petroleum. The term "petroleum" includes a great variety of substances, from a limpid liquid, too light to burn, to one that is thick and

tarry. These differ widely also in chemical composition: some yielding much asphalt by distillation, resembling a solution of asphalt in turpentine; some containing so much paraffine, that a considerable quantity can be strained out in cold weather. The asphalt in its natural form is a solid rock, to which the term "gum beds" has been applied in Canada. These differences in constitution have originated in the differences in the bituminous shales from which the petroleum, ozokerite, etc., have been derived. In Canada, as excavations are sunk through the asphalt, this becomes softer and softer, and finally passes into petroleum. This is also the case in Utah. Mr. LAY has become interested in the material, has visited all the localities of its occurrence, and is best acquainted with them.

A paper was then read by Dr. JOHN S. NEWBERRY, on

THE PHYSICAL CONDITIONS UNDER WHICH COAL WAS FORMED.

[Published in School of Mines Quarterly, 1883].

DISCUSSION.

Dr. B. N. MARTIN enquired whether any graduation has been recognized in the types of plants, in passing through the Coal-measures from below upwards.

Dr. NEWBERRY replied that differences existed, but the types were largely interlocked by insensible changes. Some floras prevail throughout the series: while, on the other hand, other types, *e.g.*, the *sigillaria*, are abundant below, but in passing upward, decrease and and disappear.

December 11, 1882.

SECTION OF CHEMISTRY.

The President, Dr. J. S. NEWBERRY, in the Chair.

Fifty-six persons present.

A crystallized specimen of native gold, of remarkable beauty, from El Dorado, Cal., belonging to Mr. TERRY, was exhibited by

the President. Prof. J. K. Rees, Director of the Columbia College Observatory, presented a report (published in the Annals) upon

OBSERVATIONS OF THE TRANSIT OF VENUS.

(Abstract).

The station occupied was the roof of the unfinished observatory of the college. The telescope was placed in the southwest corner of the roof. This roof is extraordinarily strong and solid, the beams being of iron, twelve inches in depth. Solid brick arches spring from beam to beam. The height of the roof from the street is about one hundred and ten feet. The walls supporting the roof are four feet thick. An unobstructed view was had of the whole transit. The position of the instrument was only a few feet from the old observatory, so that we may take the longitude and latitude of our instrument from the American ephemeris :—

Latitude, + 40° 45′ 23″ .1.

Longitude :—From Washington,—0h. 12m. 18.40s.

Longitude :—From Greenwich, + 4h, 55m. 53.69s.

"The timepieces used were a mean time chronometer, No. 1853, made by Parkinson & Frodsham, of London, England, and a sidereal chronometer, No. 1564, made by Negus & Co., of New York City. The instrument used in the observations was an equatorially mounted refractor by Alvan Clark & Sons. Aperture, 5.09 inches; focal length of object glass, 74.3 inches. The magnifying powers used were 48 on the I. contact, 165 on the II. and III. contacts, 95 on the IV. contact. The telescope was moved by clockwork, supplied with a Bond spring governor. In making chronometer comparisons, the sidereal chronometer was left at the college, and the mean time chronometer was carried to the instruments on which signals were to be received.

Professor Rees had prepared, but omitted to give, an elaborate system of chronometer comparisons with the Western Union time signals and the Washington time signals. The object of the comparisons was to obtain the exact error of the chronometer used at the time of the observations.

ADOPTED CONTACT TIMES.

	Mean Time of Columbia College.			Mean Time in Washington.		
	H.	M.	S.	H.	M.	S.
I	*21	8	50.0	20	56	31.6
II	21	28	45.9	21	16	27.5
III	2	52	13.5	2	39	55.1
IV	†3	11	52.1	2	59	33.7

* Notch plainly on. Estimated a minute late.
† Poor contact. Cloudy.

The observation of the first contact was interfered with by the clouds. Between the first contact and the second contact the light shining through Venus' atmosphere was a fine sight. I should say that it first appeared to my eye when the planet was a little more than half way on the sun, and disappeared about a minute before the planet reached second contact.

The line of light, marking out the portion of Venus' disk not on the sun, changed its appearance considerably while my attention was fixed upon it. I first saw a faint curved line of light off of the sun, and apparently marking out the part of Venus' disk not on the sun, this curved line being entirely disconnected from the sun. A little later this arc of light was lengthened to a semi-circular thread and touched the edge of the sun, marking out the complete outline of the part of Venus' disk not on the sun. The semi-circular gold thread seemed to be an exact continuation of the dark rim of the planet. Finally this line broadened at the point where it touched the sun's rim, or edge, and the summit of the arch disappeared. The wings of light thus formed were, at their base, not in the exact continuation of the dark outline of the planet. I watched for the repetition of these appearances between the third and fourth contacts, but failed to see anything. The sky between the first and second contacts was much clearer of haze than between the third and fourth contacts.

At second contact I saw no indication of the black drop. The tangency of Venus' and the sun's disks was well seen. During the passage of Venus over the sun's face I observed her disk with magnifying powers of 48, 95, 165 and 345, but saw no indications of an atmosphere. The disk of Venus did not appear to be uniform in blackness, but to be spotted with grayish or whitish matter, reminding one of patches of snow. This was seen under the different magnifying powers used.

When Venus neared the third contact, a very peculiar phenomenon was noticed. The preceding edge of Venus was seen to be darker than the central portion. Later the edge of the planet became of a bluish black color, and this extended around to the following edge. The phenomena connected with this were very distinct. When the planet was near third contact, these appearances were not seen longer. Just before third contact, a faint black drop was observed for a short time. It disappeared very quickly and third contact was finely seen.

The fourth contact was interfered with by the haze and clouds and was probably called too early.

Prof. H. Carrington Bolton of Trinity College, Hartford, Conn., read a paper entitled:

HISTORY OF CHEMICAL NOTATION, PART I., METALLURGIC ASTRONOMY AND ITS SYMBOLS.

(Abstract.)

He defined chemical notation as a method of expressing in symbolic characters and abbreviations the composition and mutual relations of chemical substances, and showed that it has been a marked feature of the science of chemistry in all stages of its history. Symbols occur in Greek alchemical manuscripts of the 10th and 11th centuries, several hundred of which are preserved in the foremost Libraries of Europe. The fact that symbols were in common use at a very early period is indicated by the existence of manuscripts containing keys to these signs, the so called "Lexicons of the sacred art;" these however are unsatisfactory, being almost unintelligible. We are told, for example, that "magnesia is the female antimony of Macedonia," and the expression, "sacred water," is applied to substances as diverse in nature as marble, litharge, asbestos, antimony, and white-of-egg. Among the earliest signs are those which were applied indifferently to the metals and the heavenly bodies and are still used in astronomy.

The influence of astrological ideas on alchemy was prodigious, and it is not surprising, if we reflect on the intellectual degradation of the period referred to. Several authors have discussed the mystical associations of the planets and the seven metals, and have sought to discover the origin of their common symbols. Some claim that the signs were first given to the metals and then transferred to the planets: this view was held by those influenced by the vagaries of alchemy. Others derive them from supposed resemblances to symbolic articles associated with the divinities who presided over the corresponding planets. According to the celebrated philologist Scaliger, the signs have the following origin:

♄ the scythe of Time, or Saturn.
♃ the thunderbolt of Jupiter.
♂ the lance and buckler of Mars.
☉ the disk of the Sun.
☾ the crescent of the Moon.
♀ the mirror of Venus.
☿ the caduceus of Mercury.

This symbolic derivation of the signs was very generally adopted by the historians of astronomy, especially by Lalande, Huet and Roger Long.

Salmasius regarded the symbols for the sun and the moon as ideographic, and traced the origin of the remaining five signs to hastily written initial letters of the Greek names of the planets. This is illustrated in the following table :

METAL.	Name of Planet.	Ancient Name.	Old forms of signs.	Symbols in use.
Lead	Saturn	Κρονος	♄ ϰ ϰ	♄
Tin	Jupiter	Ζευς	♃ ϰ ♃	
Iron	Mars	Θοῦρον	♂ ♂	♂
Gold	Sol	Ἥλιος	☉	☉
Copper	Venus	Φωσφόρος	♀ ♀ ♀	♀
Mercury	Mercury	Στίλβων	☿ ☿	☿
Silver	Luna	Σελήνη	☽	☽

Salmasius' theory is ingenious, and has been favorably regarded by Letronne, Delambre and others ; it has, however, weak points. Mars was commonly called πυρόεις or Ἄρης, and the epithet Θοῦρον, "impetuous," is rare. Again, the derivation of ☿ from Στίλβων seems forced, but Beckmann defends it in this wise : the old form for Σ was indisputably C, and this turned on its back and written above a τ resembles the character for mercury. The speaker stated that, in confirmation of this, he had found a sign for mercury thus ☿ . Early Greek MSS. abound in ligatures and abbreviations, which are not farther removed from their parent letters, than this sign from the initials of its ancient name.

The paper was illustrated by several diagrams giving early forms of the symbols used to designate planets and metals. The subject of alchemical symbolism in general was reserved for a future paper.

DISCUSSION.

Prof. W. GOOLD LEVISON remarked that, however obscure may be the origin of these long neglected symbols, Prof. BOLTON'S effort to trace it may be encouraged by an interest of more dignity than mere curiosity. It is no less appropriate to designate apparatuses by such symbols than the elements themselves, although in the former case they can never serve so important a purpose. For many years he has used such symbols as a short-hand method of record-

ing the results of quantitative work and has suggested the use of them to his students. When, for instance, the word "crucible" must be repeate lly entered upon a record, it is very convenient to indicate it by a cross (×) (the object from which it is derived), or by a cross within a triangle, a cross within a circle, or, if preferred, by the abbreviation "×ble" all of which were used by the alchemists. Again the letter V may conveniently be used as an abbreviation of the word precipitate, and the same symbol, inverted thus Λ, may be applied to indicate a gas.

As an illustration of the use of symbols in this way take the following common form of record of an analytical operation :

Weight of the crucible and cover containing the precipitate and ash	26.4573
" " crucible and cover alone	26.1729
Weight of the precipitate and ash	.2844
" " ash	.0010
" " precipitate=Al_2O_3	.2834

and note how much more conveniently it may be represented by symbols as follows :

W, × + c + V + *E	26.4573
W, × + c only	26.1729
W, V, + *E	.2844
W, *E	.0010
W, V=Al_2O_3	.2834

The signs he has personally used were adopted with no especial respect to conventionality, but in "Hall's Encyclopœdia," a book published in 1812, he lately met with a table of "Chymical, &c., Characters," which was engraved in 1793, and he found that many of them were identical with those he was using. So he has inserted on the inside cover of his Laboratory note book, a photographic copy of the table which seems quite complete, and such of its symbols as are appropriate he applies to a practical use.*

Chymical & Characters.

To Abstract Ā.
Acid ✠
—Marine
—Nitrous
—Phosphoric
—Vegetable ✠
—Vitriolic
Volatile Sulphureous
Æther Æ Δ.
Air A Δ Δ.
—Fixed Δ ſΔ.
—Mephitic m Δ.
Alcahest or Alcohol of Wine ⅄
An Alembic ⅄ M ⅄⅄ ⅄⅄.
Alkali ☲ S.
—Caustic Fixed c ⊖v.
—Volatile c. ⊖¹.
—Fixed ⊖v ⊖v ⊖r ⊖¹
—Milder Fixed m ⊖v.
—Vol ⊖¹ ⊖¹ ⊖¹ ⊖r
Amalgam ā ā ā Ā.
Antimony ⊖ ⊖ ♁.
—Flowers of ♁.
Aqua Fortis A AF ♀ F F.
—Regia AR ℞ R ♀.
—Vitae AV ♂ ♃.
Arsenic X ♁ ♂ ♀.
—Regulus of ♂
Ash or Ashes EA E E
—Pot or Pearl
Auripigment ♂ ⊖⊖ ⊖⊖
Bath B.
—Sand AB BA.
—Vapour VB.
—Water BM MB.
Bismuth B W.
Blood Stone
Bole Armenian AB
Borax
Bottle
Brandy AV
Brass ♀ ♀.
Calamine Stone LC
To Calcine A ♀
Camphor yr.
Caput Mortuum
To Cement
Ceruss
Cinnabar ♀ ♀ ♀ ♀ ♀.
Clay ♀.
Copper ♀.
Crab
A Crucible X + +ᵁʳ Δ ▽,
Cucubit Δ Δ.
Day ♁ ♂.
Dige ♂ ♂ ♂.
To Dissolve
To Distill
Dram } ʒ.
Drachma }
Drop G gt. gut.
Each A ā ā ā
Earth ♀
—absorbent ♀.
—of Allum A ♀ ♀.
—Calcareous
—Fluor or Fusible
—Stated ♀.
—Siliceous or Vitrescible
Essence Ess ‡.
Fire Δ.
—Circular ⊖.
—Reverberating ΔR.
Fluors
Glass XX
Gold ⊙
—Filings of
—Leaf
—Potable ⊙P
A Grain gr. o
Gum
Gypsum ♀
Half ℞ ss.
Harts Horn CC.
Honey
An Hour Σ.
Iron ♂.
—Filings
Layer upon Layer SSS.
Lead
Lime C C.
Litharge
Magnesia M ♀ M.
Mercury ☿.
—Precipitated
—of Saturn
—Sublimed
Metallic Bodies CM.
—Substances SM MS.
Mix m.
Modius M.
A Mouth M □.
Nickel N
Night ☽ ☽.
Nitre ⊖.
Oil
—Essential E. Δ.
—Fixed ♀.
—Olive
An Ounce ℥ ℥.
A Part p. p.
Phlegm
Phlogiston
Phosphorus Δ.
A Pound P ℔ p
Precipitate
Prepare PP. pp.
A Pugil P p.
Quick Lime CV ⅄ ⅄ ⊕ ♀ ♀.
Quicksilver ☿.
Quintessence QE
A Receiver
Regulus
—of Antimony Stellated
—Stellated
Retort
Saffron ⊕.
—of Copper
—of Iron ♀.
Sale ⊖
—Alkaline Q ſ.
—Ammoniac
—Common ⊖
—Gem
—Sea ⊖ ⊖ ⊖
—Sedative SS
Sand
A Scruple ℈
Seal Hermetically SH.
Steel
—Filings of
Spirit
—of Wine SV √ V
—Proof V *Tow Brandy*
—Rectified V ℞
Sublimate } ⊜.
Sublime }
Sulphur Δ Δ
—Liver of
—Mineral called Sulphur Vivum
Tale X X.
Tartar
Tin
Tutty ⊗
Urine □ □
Verdigrise ⊕
—Distilled - ⊕ dd.
Vinegar + +
Distilled X X.
Vitriol
Volatile
Water ▽
—Lime ▽.
Wax
Wine V.
—Lees X.
A Year
Zinc

* The accompanying reproduction is taken from a copy of the work in the Library of Mr. D. B. Brainerd, of Brooklyn, N. Y.

Dr. BOLTON referred to the symbol, still in use by physicians at the head of their inscriptions, as probably an altered form of the symbol of a planet, formerly adopted for the purpose of invocation.

Prof. O. P. HUBBARD stated that the specimens of Col. Gibb's famous Cabinet, Yale College, imported from Europe in 1805, originally in large part brought from Russia, still retained, as late as the year 1836, circular labels marked with these ancient symbols of the metals.

The PRESIDENT stated that the heading of the prescriptions of modern physicians was commonly understood to be an antique **℞**, standing for the Latin word, Recipe (Take!) However, this explanation was probably incorrect, the symbol having descended from antiquity.

The subject was further discussed by Mr. HAWKINS and other members.

December 18, 1882.

The President, Dr. J. S. NEWBERRY, in the Chair.

Sixty-four persons present.

The resignation of Dr. W. I. BAUER, as a Resident Member, was accepted.

A paper was read by Mrs. ERMINNIE A. SMITH, illustrated with early and remarkable manuscripts, dictionaries, etc., entitled:

LANGUAGE OF THE IROQUOIS INDIANS.

The impossibility of clearly understanding a people or its literature, especially the latter if it be unwritten, without some knowledge of its language or medium of thought, cannot be disputed.

Admitted as they are to be the most remarkable of all our American Indians, and those most intimately connected with our early national history, it is unaccountable that so little has been known of the six Iroquois dialects.

A brief, but as it has since proven most important Mohawk vocabulary, taken down in the 16th century by Jacques Cartier; a small Latin-

Mohawk dictionary by the Jesuit Father Bruyas, and another in French-Onondaga by a priest of the same order of the 17th century, have for some time been in the possession of students. Beyond this, the Mohawk prayer-book by Brant, a few gospels and hymns in several of the dialects, a few numbers of a Seneca periodical, edited by their missionary, Mr. Wright, a spelling-book by the same author, together with numerous very incorrect short vocabularies in each of the dialects, and later, a few interesting pamphlets concerning the Mohawk by Père Cuoq, constitute all the published material heretofore within reach of the historian, philologist or ethnologist.

Some account therefore of my labors in this direction, after the uniform scientific system, originated by the Bureau of Ethnology, and in use by those engaged in its service, may prove of interest.

That these Six Tribes were originally but one is obvious from a comparison of the six dialects. The chart on exhibition contains some of the words in most frequent use, and illustrates the character of their dissimilarities. The dialect spoken by the Tuscaroras, who were for a time widely separated from the others, presents the greatest differences.

That this period of separation was not of necessity one of great length, may be inferred from the remarkable differences which have arisen between two portions of the Mohawk tribe, less widely separated for a little more than two centuries.

On exhibition are the completed chrestomathies of the Seneca, Onondaga, Mohawk and Tuscarora dialects, prepared for the Bureau of Ethnology, after its admirable system of phonetic spelling and with its highly perfected alphabet for Indian dialects.

To obtain synonyms for the newly collected 8,000 Tuscarora words, the nucleus to an Iroquoian dictionary, the Catholic missions on the Canadian banks of the St. Lawrence were selected as the field for inquiry.

Over two hundred years ago, the ancestors of these Mohawks were christianized and transplanted to these missions from among their pagan surroundings, south of Lake Ontario, by the zealous Jesuit missionaries.

The archives of the old Catholic Church at Caughnawaga were found to contain, among other interesting and remarkable manuscripts, the most valuable French-Mohawk dictionary, now before you, compiled by Father Marcoux in the early part of this century.

Through the kindness of Superior Antoine and Père Burtin, this will furnish the desired synonyms, many of which would otherwise have been unobtainable.

Through their courtesy and that of Père le Clair, the Superior of the Sulpician Seminary at Oka, several hundred new titles were, during the

past summer, added to the catalogue of Indian Linguistics, being edited by Mr. Pilling at Washington.

The black-board illustrations show the extreme length of some of the words, and, in their dissection, illustrate their marvelous composition.

For example, the following shows how the accidents of an Indian verb may affect its length, to the extent of producing in one word a very complicated phrase, viz. :

Le-côñ-wâ-ti-at-â-wit-se-ra-h-ni-non-se-ron-ni-ôñ-tôñ-ha-ti-es.—43 letters, 21 syllables.

The translation of this word is as follows:

Some one has just come here expressly to buy again all kinds of clothes with that (*money*).—66 letters, 20 syllables.

There is in this verb, 1st, the relation of the third person indefinite to the third masculine.

2d. Composition of the verb, *ni-non* (*to buy*), with the noun, *â-ti-ât-a-wit* (*clothes.*)

3d. Final relative, (*to buy for some one*).

4th. Movement, *se-ron* (*come to buy*).

5th. Frequentation, *ni-on.*

6th. Causality, *tôñ*, added to the perfect.

7th. Reduplication and locality, together denoted by *te* before the person.

8th. Transition, *ha-ti-e*, added to the perfect of the verb, denoting the transition from one place or one state to another, or the progress of the same state or action. This word is of unusual length.

What the possibilities of this group were, we can at present only conjecture, and should hasten to preserve them with all their hidden lore, ere they have been forever displaced by that more rapid vehicle of thought, the English language.

Discussion.

Bishop Stimpson, of Ontario, Canada, confirmed the general accuracy of Mrs. Smith's observations. He stated also, that at Rice Lake, opposite Rochester, one of the tribes resident there, which still refuses to accept Christianity, had come originally from the Mohawk Valley, in New York.

In reply to enquiries of Prof. O. P. Hubbard, Mrs. Smith stated that the league of the Six Tribes probably occurred over 300 years ago, but the date was uncertain. Contrary to a general opinion,

however, such leagues were not rare, but had been commonly formed among other Indian tribes.

The reason of the great difference in the language of the Tuscaroras from those of the other tribes, was due to the fact that the Tuscaroras formerly lived in North Carolina, and were thence driven out, in 1712, came North to the Confederation of the five tribes of the Iroquois, and formed the sixth tribe. Their original isolation had probably caused these dialectic differences.

General Ely Parker, spoke on the early history of the Tuscaroras, and the necessary conciseness of their language, which contains no circumlocutions, hardly any words with double-meaning. A similar mythology runs through all the tribes, which embraces a multiplicity of gods, *i.e.*, the spirits of familiar but important objects, *e.g.*, of the strawberry, maple, chestnut, oak, etc. At the annual festivals, as that of First Fruits (the strawberry), or that of Green Corn, they refer to all these spirits, but at the same time to a great Good Spirit, who presides over them all. They believe also in many evil spirits. They have never had any written language; oral tradition was their only possible means for handing down matters of history; but it was necessary to present them in a fanciful form in order to impress the youthful mind—not merely the bare abstract facts. These people are dying out, and the valuable materials of their history, language, etc., are passing beyond our reach. Even in New York State, the few remaining Indians on the Reservation, are being affected by the influences of civilization around them, and will soon lose their tribal connection, their Indian habits and Indian memories. It is important to collect this material now, and assist investigations of this kind.

Dr. B. N. Martin expressed his gratification over researches so original, novel, and interesting, and remarked, that it sounded strangely to speak of the history of the races, who so recently trod and ruled over our soil, as a novel subject. The peculiar feature of the Indian language, the use of undivided long words, conveying all shades of thought without separation, throws light on the origin of language among primitive peoples.

Rev. Dr. Dacosta referred to recent re-searches of a student of the Indian languages, who by means of carefully compiled tables,

had found a similarity in the system of nomenclature of rivers, something resembling the Latin, *aqua*.

The subject was further discussed by Mr. R. JOHNSON, in regard to the poetry of the Indians, and by a VISITOR, who had found apparent resemblances between words of the Chippewa and Oriental languages. For the names of rivers, very figurative expressions were used by the Chippewas, *e.g.*, the great gathering of waters (Mississippi), the river that follows the shore, the straight river (Hiwassee), the middle river, the river beyond the land, etc.

Mrs. SMITH had remarked that, in the Iroquois names of rivers, some terms imply "flowing," but no definite system prevailed. Five hundred Indian tongues have been spoken in the United States, but little is yet known concerning any of these; and it seems both difficult and unwise to endeavor to trace analogies among them, before a single one has been thoroughly studied.

The PRESIDENT stated that the literature and destiny of the Indians had always been a subject of great interest to him. He had been among forty tribes, and had known something of the value of the materials, as bearing on the origin, structure and mutations of languages, which are soon to be lost. He had been associated for a time with George Gibbs, and with Turner, whose linguistic investigations were of the greatest value, and whose early death was much to be deplored. The subject under discussion was of the highest scientific character. The work of the Bureau of Ethnology promises to give a very important and well-digested series of investigations in regard to the Red Men, in place of the hasty observations and generalizations of Schoolcraft, and even those of Parkman, which are for the most part guess-work. Only by going among this people is their real spirit to be understood, and in this way the basis for a true history of the aboriginal occupants of this country will soon be gained. The policy of the early Government and colonists of Canada, and of some of our own colonists, *e.g.*, those of Penn, was a just one in the treatment of the Red Men, and very useful in the collection of ancient records which are now doubly precious. A very important contribution to history will be acquired when all these materials shall be properly arranged and written out.

January 8, 1883.

REGULAR BUSINESS MEETING.

Vice-President, Dr. B. N. MARTIN, in the Chair.

Twenty persons present.

Mr. C. E. COLBY was elected Resident Member, and the resignation of Mr. E. VANSYCHEL was accepted.

It was "*Resolved*, that the Publication Committee be authorized to prepare and publish an appeal for additions to the General Publication Fund."

Dr. ALBERT R. LEEDS read a paper, illustrated by specimens, upon FIVE NEW ORGANIC COMPOUNDS, VIZ:—ŒNANTHOLANILINE, ŒNANTHOLXYLIDINE, ŒNANTHOLNAPHTHYLAMINE, CRYPTIDINE, AND ACROLEINUREIDE.

(Abstract).

Œnanthol was prepared by fractional distillation at 150° of castor oil in partial vacuo. It unites, with great energy and elevation of temperature, with the aromatic bases, to form oils of closely related physical properties.

Purification by distillation was found impracticable, as was also the use of solvents, such as alcohol, benzol, chloroform and carbon disulphide. Finally the following plan proved successful. Each of the three compounds was dissolved in 150 grms. glacial acetic acid, heated for some hours on the water-bath, and, after complete combination of the excess of aromatic base, was converted into its respective acetic acid salt. A large excess of water was added, which precipitated the œnanthol compound, whilst the salt of the aromatic base remained in solution. After complete washing with water and drying at 100° C., the new compounds were submitted to analysis.

Œnantholaniline, C_8H_7N, $C_7H_{14}O$, is a reddish mobile oil of pleasant etherial smell; so is œnantholxylidine, $C_8H_{11}N$, $C_7H_{14}O$, and œnantholnaphthylamine, $C_{10}H_9N$, $C_7H_{14}O$. In the last case, the etherial smell is very pronounced and agreeable, resembling the odor of pineapple.

It is remarkable that these compounds, formed synthetically by the direct union of a molecule of œnanthol with a molecule of the aromatic base, without the elimination of molecule, should evolve so great heat of combination. They are permanent compounds, and can be sublimed with only partial decomposition. The sublimates are not crystalline,

and are identical in their physical and chemical properties with the original bodies.

By careful sublimation of xylidinacrolein, an oil is obtained which has an unpleasant smell and very bitter taste. It forms crystalline salts with sulphuric, hydrochloric and other acids. That with hydrochloric acid, after repeated purification by crystallization, was decomposed with caustic potash. The oil thus obtained was distilled at 270°, and yielded an oil of reddish color, unpleasant smell, and having the composition of cryptidine, $C_{11}H_{11}N$.

This is the first successful attempt to isolate this member of the pyridine series, only its salts having been obtained before, and it is of further interest as being accomplished by a process of synthesis.

This synthesis moreover throws light on the composition of these pyridine bases; since the mode of formation renders it probable that cryptidine contains one benzol ring, united with a side ring formed from the pre-existent members of the acrolein derivative of the fatty bodies.

The various oils derived from castor-oil were then described, and the different views of the constitution of these compounds.

Finally, the compounds of acrolein and urea were discussed, and the various statements put forth by HUGO SCHIFF concerning them.

DISCUSSION.

Mr. A. H. ELLIOTT pointed out the apparent identity in odor of cryptodine with a substance found in bone-oil, which he had obtained in considerable quantity in the oil derived from the destructive distillation of bones. This oil was nearly colorless, yielded the same odor as the one exhibited, had a specific gravity 0.835, and afforded, with hydrochloric and sulphuric acids, red salts which turned jet black in the air, though both their color and this change might have been due to some other substance present.

The subject was further discussed by Profs. MARTIN and LEEDS.

January 15, 1883.

LECTURE EVENING.

The President, Dr. J. S. NEWBERRY, in the Chair.

The large hall was filled by an audience who listened with inter-

est to a lecture, illustrated by many diagrams, by Prof. EDWARD D. COPE, of Philadelphia, on

THE EVOLUTION OF THE VERTEBRATA.

January 22, 1883.

The President, Dr. J. S. NEWBERRY, in the Chair.

Seventy-five persons present.

Mr. G. F. N. KUNZ exhibited specimens of chrysoberyl, of remarkable size (one five by three inches), and crystalline marking, from Canton and Stowe, Me., and of rhodochrosite on drusy quartz from the Clay mine, Lake City, Col.; and Mr. N. L. DARTON, specimens of franklinite and chalcophanite from Sterling, N. J., iron ores from Marquette, Mich., and tabular calcite with drusy quartz from Anthony's Nose, N. Y.

A paper was read by Prof. EDWARD P. THWING on

THE TREATMENT OF SEA-SICKNESS BY THE TRANCE STATE.

(Abstract).

The phenomena of the trance have interested me for more than twenty years. For two years my experiments have confirmed the theory of Dr. Geo. M. Beard, that the concentration of the mind's attention in one direction induces an insensibility to other things, more or less complete. President Porter (Elements of Intellectual Science, section 81) says that pure sensation is simply an ideal or imaginary experience, and that, as the perceptional element is made stronger, the sensational is weakened. The intensity of the one is the suppression of the other. Some persons can excite expectancy sooner than others, and so gain control quicker. Some subjects take a consenting attitude more readily than others. One yields instantly, another only after repeated interviews, and some, perhaps, may never yield at all.

Nine cases of sea-sickness, occurring in the Atlantic and in foreign seas, are selected from many, to illustrate the speedy relief, often the complete cure, of this distressing ailment. Some showed little somnolence, while others sunk into as complete insensibility as in ordinary anæsthesia by chloroform.

One patient had been unable to retain any nourishment on the stomach after leaving port, two days' previous. Manipulations began about the temporal and frontal regions, particularly along the super-

ciliary ridges, and the patient at once exclaimed: "What a heaven to be relieved of pain!" Food was administered in small quantities, and, two hours after, a dinner of roast mutton was relished and retained. The other cases were treated in a similar manner, without the "passes" of the old-time mesmeriser, or the pretentious and dramatic display seen in stage exhibitions, without even fixing the gaze or standing before the individual. The voice probably did more than the hand, but in one case that, too, seemed superfluous; for the sufferer, a brawny Welshman, not understanding English, while busy casting his bread upon the waters, yielded to a pantomime, was led away from the ship side and made to recline on the shoulder of the operator. The trance became at once so profound that a pin introduced and left in the skin covering the back of the hand caused no wincing. Surgical operations have also been performed, some of which will be described by Prof. Jarvis of Bellevue College. Four facts may be stated as results:

1. The trance state in many cases relieves sea-sickness by restoring nervous equilibrium, and in surgery is sometimes an adequate substitute for ether. Not every one responds. Not every one is able to awaken that faith, belief, expectancy, which Dr. Beard has already shown before this Academy to be the subjective state out of which all these phenomena are evolved. This persuasion cometh not readily to every willing, yielding soul, still less to a reluctant, incredulous mind. Failures are mostly found in two classes. 1. The querulous, dogged, despairing sort, who, at home or afloat, nurse their pains and "enjoy poor health," as they say. 2. The curious, voluble and volatile, who wish to listen to and join in conversation. But failures with these, at the first or second meeting, are by no means final or decisive. Sequestration and silence on the part of the patient, and perseverance on the part of the operator, often secure success in apparently obstinate cases.

2. Tranciform states, *i. e.*, where control is partial and unconsciousness is incomplete, frequently afford proportionate relief.

3. The sense of subjugation and helplessness that comes over one, when in the grasp of Neptune or the surgeon, is sometimes a helpful accessory. It is analogous to the yielding attitude of the animal under a tamer or trainer, and not unlike the paralyzing influence of a panic.

4. The feeling of certainty on the part of the operator is a vital factor of success. It cannot be taught. It is gained by victorious achievement. Nothing is so successful as success. One subject under control will spread psychical contagion through a whole assembly, and at once exalt their ideas of the power of the controller. In private practice assurance is better shown by gentleness than by bluster, by undemonstrative, quiet tones, and by the general air of one who speaks

a personal, private, authoritative message, which he is accustomed to have immediately obeyed. *Possunt quia posse videntur.* Hardly anything is more contagious than confidence. Nothing is more masterful in power.

DISCUSSION.

Dr. W. C. JARVIS presented a patient from whose nasal fossa he had cut diseased turbinated tissue, while made to sleep by Prof. Thwing. There was in the second operation no wincing and no memory of pain. Respiration through the right nostril had thus been resumed after a year's closure. Another patient, so terrified on a previous occasion as to require three attendants to hold her, was enabled by the trance treatment to submit to the removal of a tumor behind the palate, near the base of the brain, remaining in a state of complete insensibility during the operation. He remarked upon the benefit of the possession of an influence so potent in preventing pain, especially in nervous cases, which are peculiarly susceptible to pain.

The CHAIRMAN remarked that these phenomena were not new but had been repeated for ages. Twenty-five years ago, when he was a medical student in Paris, he had seen Dr. Malgaigne, the distinguished surgeon, utilize this power in surgery. It could not always be depended upon, as a considerable number, perhaps the majority of cases would resist the influence, and with them the power is useless. There was no propriety or policy in denouncing it as a humbug, though unnecessary to clothe it with any wonder or mystery. It was a beneficial, wholesome influence, worthy all the attention being paid to it. It had been taken out of the hands of charlatanism and was now being properly studied and utilized.

A paper was then read by Dr. JOHN S. NEWBERRY, illustrated by a collection of plants and by lantern views, entitled:

NOTES ON THE BOTANY, GEOLOGY AND RESOURCES OF SOUTHERN TEXAS AND CHIHUAHUA.

(Published beyond, under report of meeting of Feb. 12).

January 29, 1883.

SECTION OF GEOLOGY.

The President, Dr. J. S. NEWBERRY, in the Chair.

Seventy-five persons present in the large Hall.

The President announced the death of a Resident Member, Dr. GEORGE M. BEARD, and remarked on his scientific attainments, and investigations of the phenomena of mesmerism and the trance state.

Dr. A. A. JULIEN read a paper on

"THE DECAY OF THE BUILDING STONES OF NEW YORK CITY,"

(with Lantern Illustrations from American and Foreign Architecture).

(Abstract).

The paper, which will be published in full by the Building-Stone Department of the Tenth Census of the United States, considers the building stones employed in New York City and its suburbs, *i.e.*, Brooklyn, Staten Island, Jersey City and Hoboken.

I. The buildings, their numbers and common materials.

The materials of general construction occur in the following percentage proportion to the total number of buildings in the cities stated in the table below:

	New York.	Brooklyn.	Staten Island.	Jersey City.	Hoboken.	Entire Metropolis.
No. of buildings..	100,193	75,526	7,725	20,880	6,284	210,608
Brick and stucco.	63.2	39.9	9 5	22.8	32.7	47.9
Frame.....	24.3	50.9	90 0	75.2	64.7	42.5
Stone.....	11.6	9.1	0.5	2.0	2.6	9.1
Iron..... ...	0.9	0.1				0.5

In New York City proper, the several varieties of stone are used in the following proportion to the entire number of stone buildings:

Brown sandstone.....	78.6	Ohio sandstone.....	1.6
Nova Scotia sandstone.....	9 0	Gneiss.....	0.9
Marble..... ..	7.9	Foreign sandstone..	0.1
Granyte.....	1.8	Bluestone and limestone....	0.1

In Brooklyn, the Connecticut brownstone is the variety predominating

among the stone buildings (95.7 per cent), and is employed almost altogether for the fronts of residences. Very few iron buildings occur, but over three times as many stucco-fronts as in New York. The frame buildings predominate, particularly in the outskirts, *e. g.*, Long Island City (80.5 per cent).

In Staten Island, stone enters in very small proportion into the fronts of buildings, though commonly employed, as in New York and throughout this district, for the dressing of apertures, the walls of enclosures, and other masonry.

In Jersey City, the proportions of the materials are much as in Staten Island. The selection of the dark trap from the Heights behind the city, for the construction of many fronts or entire buildings, is a local feature of interest.

In Hoboken, the same general features prevail as in Jersey City.

The annual reports of the Committee on Fire Patrol of the New York Board of Fire Underwriters, for the years 1881 and 1882, have yielded the following statistics, which, so far as they go, closely approximate my own:

	Number of buildings.
South of Canal street	10,553
Between Canal and Fourteenth streets	26,700
Between Fourteenth and Fifty-ninth streets	33,815
Between Fifty-ninth street and Harlem River	18,746
Total	89,814

The materials of construction for this district, which does not include the 23d and 24th Wards, North of the Harlem river, are reported as follows:

Brick, with stone trimmings, and, in part, with stone facings	64,783
Brick and frame	3,616
Frame	21,415

II. *The Building Stones, their Varieties, Localities, and Edifices Constructed of Each.*

An exceedingly rich and varied series is brought to our docks, and the number and variety are constantly increasing. A few of the more important may be here mentioned.

Freestones (Carboniferous Sandstone), commonly styled "Nova Scotia Stone," or "Dorchester Stone," in various shades of buff, olive-yellow, etc., from Hopewell and Mary's Point, Albert, N. B., and from Wood Point, Sackville, Harvey, and Weston, N. B., Kennetcook, N. S., etc. A very large number of private residences in New York and

Brooklyn, etc., the fences, bridges, etc., in Central and Prospect Parks, many churches, banks, etc.

Freestone (Mesozoic Sandstone), commonly styled "brownstone," from East Longmeadow and Springfield, Mass., but chiefly from Portland, Conn., in dark shades of reddish-brown, inclining to chocolate. This is the most common stone used in the fronts of private residences, many churches, Academy of Design in Brooklyn, etc.

Freestone (Mesozoic Sandstone), "brownstone," from Middletown, Conn. Trinity Church, Brooklyn, etc.

Red Sandstone (Potsdam Sandstone), Potsdam, N. Y. Several residences, buildings of Columbia College, etc.

Freestone (Potsdam Sandstone), "brownstone," Oswego, N. Y. Part of Masonic Temple in 23d street.

Freestone (Mesozoic Sandstone), "brownstone," in several shades of light reddish-brown, orange-brown, etc., and generally fine-grained, from Belleville, N. J. Very many of the best residences and churches, *e.g.*, cor. 60th and 64th streets and Madison avenue, etc.

Also, varieties of the same "brownstone" from Little Falls, N. J. (Trinity Church, New York), from the base of the Palisades (part of the wall around Central Park), etc.

Freestone (Lower Carboniferous Sandstone), commonly styled "Ohio Stone," from Amherst, East Cleveland, Independence, Berea, Portsmouth, Waverly, etc., Ohio, in various shades of buff, white, drab, dove-colored, etc. Many private residences and stores, the Boreel building, Williamsburgh Saving Bank, Rosssmore Hotel, etc.

Freestone (Mesozoic Sandstone), often styled "Carlisle Stone," from the English shipping port, or "Scotch Stone," from Corsehill, Ballochmile and Gatelaw Bridge, Scotland; in shades of dark red to bright pink. Fronts of several residences, trimmings of Murray Hill Hotel, the "Berkshire" building, etc.

Also, varieties from Frankfort-on-the-Main, Germany, etc.

Blue Sandstone (Devonian Sandstone), commonly styled "Bluestone," from many quarries in Albany, Greene, Ulster and Delaware counties, N. Y., and Pike county, Penn. The trimmings of many private residences and business buildings, walls and bridges in the Parks, part of Academy of Design in 23d street, Penitentiary on Blackwell's Island, house at 72d street and Madison avenue, etc.

Freestone (Oolite Limestone), "Caenstone," from Caen, France. Fronts of several residences in 9th street, trimmings of Trinity Chapel, the reredos in Trinity Church, New York, etc.

Limestone (Niagara Limestone), Lockport, N. Y. Lenox Library, trimmings of Presbyterian Hospital, etc.

Limestone (Lower Carboniferous), styled "Oolitic Limestone," from Ellitsville, Ind. Several private residences, (*e.g.*, cor. 52d street and Fifth avenue), trimmings of business buildings, etc.

Also, varieties of limestone from Kingston and Rondout, N. Y., Isle La Motte, Lake Champlain, Mott Haven, and Greenwich, Conn., etc. Part of the anchorages of the Brooklyn Bridge, walls in Central Park, etc.

Granyte, Bay of Fundy, N. S. Columns in Stock Exchange, etc.

Red Granyte, Blue Hills, Me. U. S. Barge Office.

Gray Granyte, East Blue Hills, Me. Part of towers and approaches of New York and Brooklyn Bridge, etc.

Granyte, Spruce Head, Me. Part of towers of Brooklyn Bridge, bridges of Fourth Avenue Improvement, Jersey City Reservoir, etc.

Gray Granyte, Hurricane Island, Me. Part of New York Post Office and of towers and approaches of Brooklyn Bridge, etc.

Granyte, Fox Island, Me. Basement of Stock Exchange, etc.

Granyte, Hallowell, Me. Trimmings in St. Patrick's Cathedral, Jersey City Heights, etc.

Granyte, Round Point, Me. Seventh Regiment Armory, etc.

Granyte, Jonesborough, Me. Welles' building, panels in Williamsburgh Savings Bank, etc.

Granyte, Frankfort, Me. Part of towers and approaches of Brooklyn Bridge, etc.

Granyte, Dix Island, Me. New York Post Office, part of *Staats Zeitung* building, etc.

Also, varieties from Calais, Red Beach, East Boston, Clark's Island, Mt. Waldo, Musquito Mountain, Mt. Desert, Ratcliff's Island, etc., Me.

Granyte, Concord, N. H. Booth's Theatre, German Savings Bank, etc.

Granyte, Cape Ann, Mass. Dark base-stone and spandrel stones of towers and approaches of Brooklyn Bridge, etc.

Granyte, Quincy, Mass. Astor House, Custom House, etc.

Granyte, Westerly, R. I. Part of Brooklyn anchorage of Brooklyn Bridge.

Granyte, Stony Creek, Conn. Part of New York anchorage of Brooklyn Bridge.

Also, varieties from St. Johnsville, Vt., Millstone Point, Conn., Cornwall, N. Y., Charlottesburg, N. J., Rubislaw and Peterhead, Scotland, etc.

Gray Gneiss, New York Island and Westchester County, N. Y. A large number of churches, Bellevue Hospital, the Reservoir at 42d

street, etc., and the foundations of most of the buildings throughout the city.

Gray Gneiss, Willett's Point and Hallett's Point, Kings County, N. Y. Many churches in Brooklyn, the Naval Hospital, etc.

Marble, Manchester, Vt. Drexel & Morgan's building, church corner 29th street and Fifth avenue, etc.

Also, many varieties from Swanton, West Rutland, Burlington, Isle La Motte, etc., Vt. The "Sutherland" building at 63d street and Madison avenue, residences at 58th street and Fifth avenue, etc.

Marble, Lee, Mass. Turrets of St. Patrick's Cathedral, etc.

Marble, Stockbridge, Mass. Part of old City Hall, New York.

Marble, Hastings, N. Y. The University building, etc.

Marble, Tuckahoe, N. Y. Part of St. Patrick's Cathedral, residence on the corner of 34th street and Fifth avenue, etc.

Marble, Pleasantville, N. Y., styled "Snowflake Marble." Greater part of St. Patrick's Cathedral, Union Dime Savings Bank, many residences and stores, etc.

Also, many varieties from Canaan, Conn., Williamsport, Penn., Knoxville, Tenn., Carrara and Sienna, Italy, etc.; used generally, especially for interior decoration, etc.

Trap (Mesozoic Diabase), from many quarries along the "Palisades," at Jersey City Heights, Weehawken, etc. Stevens' Institute, Hoboken, N. J., Court House on Jersey City Heights, old rubble-work buildings at New Utrecht, etc., on the outskirts of Brooklyn, etc.

Trap (Mesozoic Diabase), styled "Norwood Stone," from Closter, N. J. Grace Episcopal Church, Harlem.

Also, varieties from Graniteville, Staten Island, N. Y., and Weehawken, N. J.

Serpentine, Hoboken, N. J. Many private residences, masonry, etc., in Hoboken. Also, varieties from Chester, Penn.

In addition to the edifices referred to above, many public buildings of importance are constructed of stone, *e.g.*: Prisons in the city and on the islands, bridges in the Parks and over the Harlem river, in which sandstone, limestone, granyte and gneiss are used.

The sewers are constructed of gneiss from New York Island and vicinity, as well as of boulders of trap, granyte, etc., from excavations.

The Croton Aqueduct, the High Bridge, the Reservoirs in the Central and Prospect Parks and at 42d St., in which gneiss from the vicinity and granyte from New England were used.

The walls, buildings, bridges and general masonry in the Parks are constructed of the following varieties of stone:

Freestone (sandstone), from Albert, Dorchester, and Weston, N. B.

Brownstone, from Belleville and the base of the Palisades, N. J.

Bluestone and "mountain graywacke," from the Hudson River.

Limestone, from Mott Haven and Greenwich, Conn.

Granyte, from Radcliffe's Island, etc., Me.

Gneiss, from New York, Westchester and Kings counties, N. Y.

Marble, from Westchester county, N. Y.

The fortifications in the Harbor and entrance to the Sound, constructed of granyte from Dix Island, Spruce Head, etc., Me., gneiss from the vicinity, brownstone from Conn., etc.

The stonework of the New York and Brooklyn Bridge, as I am kindly informed by Mr. F. Collingwood, the engineer in charge of the New York Approach, is constructed of the following materials:

Granyte, from Frankfort, Spruce Head, Hurricane Island, East Blue Hill, and Mt. Desert, Me., Concord, N. H., Cape Ann, Mass., Westerly, R. I., Stony Creek, Conn., and Charlottesburg, N. J.

Limestone, from Rondout and Kingston, N. Y., also from Isle La Motte and Willsboro Point, Lake Champlain, and vicinity of Catskill, N. Y.

In the Anchorages, the corner-stones, exterior of the cornice and coping, and the stones resting on anchor-plates, consist of granyte from Charlottesburg and Stony Creek, in the New York Anchorage, and from Westerly, in the Brooklyn Anchorage. The rest of the material is entirely limestone, mainly from Rondout, largely from Lake Champlain. In the Towers, limestone was chiefly employed below the water line, and, above, granyte from all the localities named, except Charlottesburg, Westerly and Stony Creek. In the Approaches, the materials were arranged in about the same way as in the Towers. Additional particulars are given concerning the quantity, prices, tests of strength and reasons for selection of the varieties of stone.

For roofing, slate is largely employed throughout these cities, being mainly derived from Poultney, Castleton, Fairhaven, etc., Vt., and Slatington, Lynnport, Bethlehem, etc., Penn.

For pavements, the boulders of trap and granyte from excavations have been widely used in the "cobbletone" pavements. The trap (or diabase) of the Palisades across the Hudson, immediately opposite New York City, and from Graniteville, Staten Island, is used in the "Russ" and Belgian pavement; also, granyte from the Highlands of the Hudson, from Maine, etc., in the "granite block" pavement in both New York and Brooklyn; large quantities of crushed trap from Weehawken and Graniteville, for the macadamized streets and roads in the Parks and outskirts; and also wood, concrete and asphalt in various combinations.

For sidewalks and curb-stones, the material generally employed is the flagstone, a thinly bedded blue sandstone or graywacke from the interior of the State, the Catskill Mountains, and from Pennsylvania; also, granyte, chiefly from Maine. In the older streets, a mica-slate from Bolton, Conn., and micaceous slaty gneiss from Haddam, Conn., were once largely used, and may still be occasionally observed in scattered slabs.

Additional facts were given concerning the ruling prices for the varieties of stone, tables presenting all the determinations obtainable, in reference to the crushing strength of the varieties used in New York, lists of the dealers in building and ornamental stones, etc.

III. *Durability of Building-Stones*, in New York City and vicinity.

All varieties of soft, porous and untested stones are being hurried into the masonry of the buildings of New York City and its vicinity. On many of them the ravages of the weather and the need of the repairer are apparent within five years after their erection, and a resistance to much decay for twenty or thirty years is usually considered wonderful and perfectly satisfactory.

Notwithstanding the general injury to the appearance of the rotten stone, and the enormous losses annually involved in the extensive repairs, painting, or demolition, little concern is yet manifested by either architects, builders, or house owners. Hardly any department of technical science is so much neglected as that which embraces the study of the nature of stone, and all the varied resources of lithology in chemical, microscopical, and physical methods of investigation, wonderfully developed within the last quarter century, have never yet been properly applied to the selection and protection of stone, as used for building purposes. Much alarm has been caused abroad in the rapid decay and fast approaching ruin of the most important monuments, cathedrals, and public buildings, but in many instances the means have been found for their artificial protection, *e.g.*, the Louvre and many palaces in and near Paris, France, St. Charles church in Vienna, Austria, the Houses of Parliament, etc., in London, England, etc.

In New York, the Commissioners of the Croton Aqueduct Department complained, twenty years ago, of the crumbling away of varieties of the gneiss used in embankments; the marbles of Italy, Vermont, and of Westchester County, soon become discolored, are now all more or less pitted or softened upon the surface (*e.g.*, the U. S. Treasury), and are not likely to last a century in satisfactory condition (*e.g.*, the U. S. Hotel); the coarser brown sandstones are exfoliating in the most offensive way throughout all of our older streets and in many of the

newer (*e.g.*, the old City Hall); the few limestones yet brought into use are beginning to lose their dressed surfaces and to be traversed by cracks (*e.g.*, the Lenox Library); and even the granytes, within a half century, show both discoloration, pitting (*e.g.*, the Custom House), or exfoliation (*e.g.*, the Tombs). To meet and properly cope with this destructive action, requires, first, a clear recognition of the hostile external agencies concerned in the process. These belong to three classes, chemical, physical, and organic.

The chemical agencies discussed were the following: sulphurous and sulphuric acids, discharged in vast quantities into the air of the city, by the combustion of coal and gas, the decomposition of street refuse and sewer-gas, etc.: carbonic, nitric, and hydrochloric acids; carbolic, hippuric, and many other organic acids, derived from smoke, street dust, sewer vapors, etc.: oxygen and ozone, ammonia, and sea-salt.

The mechanical and physical agencies discussed were the following: frost: extreme variations in temperature, amounting in our climate to 120° F. in a year, and even 70° in a single day: wind and rain, most efficient on fronts facing the north, northeast, and east: crystallization by efflorescence: pressure of superincumbent masonry: friction: and fire.

The organic agencies consist of vegetable growths, mostly confervæ, etc., within the city, and lichens and mosses, without, and of boring molluscs, sponges, etc.

The internal elements of durability in a stone depend, first, upon the chemical composition of its constituent minerals and of their cement. This involves a consideration of their solubility in atmospheric waters, *e.g.*, the calcium-carbonate of a marble or limestone, the ferric oxide of certain sandstones, etc.: their tendency to oxidation, hydration, and decomposition, *e.g.*, of the sulphides (especially marcasite) in a roofing-slate or marble, the biotite and ferruginous orthoclase in a granyte or sandstone, etc.: the enclosure of fluids and moisture, *e.g.*, as "quarry-sap," in chemical combination as hydrated silicates (chlorite, kaolin, etc.) and iron-oxides, and as fluid-cavities locked up in quartz, etc.

The durability of a stone depends again upon its physical structure, in regard to which the following points were discussed: the size, form, and position of its constituent minerals; *e.g.*, an excess of mica-plates in parallel-position may serve as an element of weakness: the porosity of the rock, permitting the percolation of water through its interstices, especially important in the case of the soft freestones and leading to varieties of discoloration upon the light-colored stones, which were described in detail: the hardness and toughness, particularly in relation

to use for pavements, sidewalks, and stoops: the crystalline structure, which, if well-developed, increases the strength of its resistance: the tension of the grains, which appears to explain especially the disruption of many crystalline marbles: the contiguity of the grains and the proportion of cement in their interstices: and the homogeneity of the rock.

Again, the durability of a rock may depend upon the character of its surface, whether polished, smoothly dressed, or rough-hewn, since upon this circumstance may rest the rapidity with which atmospheric waters are shed, or with which the deposition of soot, street-dust, etc., may be favored: also upon the inclination and position of the surface, as affecting the retention of rainwater and moisture, exposure to northeast gales and to burning sun, etc.

IV. *Methods of Trial of Building-Stone.*

In such methods, two classes may be distinguished, the natural and the artificial.

The former embrace, first, the examination of quarry-outcrops, where the exposure of the surface of the rock during ages may give some indication of its power of resistance to decomposition, *e. g.*, the dolomitic marbles of New York and Westchester counties, some of which present a surface crumbling into sand: and, secondly, the examination of old masonry. Few old buildings have survived the changes in our restless city, but many observations were presented in regard to the condition of many materials, usually after an exposure of less than half a century.

Another source of information, in this regard, was found in the study of the stones erected in our oldest cemeteries, *e.g.*, that of Trinity Church. There could hardly be devised a superior method for thoroughly testing, by natural means, the durability of the stone, than by its erection in this way, with partial insertion in the moist earth, complete exposure to the winds, rain, and sun on every side, its bedding-lamination standing on edge, and several of its surfaces smoothed and polished and sharply incised with dates, inscriptions, and carvings, by which to detect and to measure the character and extent of its decay. In Trinity Church-yard, the stones are vertical, and stand facing the east. The most common material is a red sandstone, probably from Little Falls, N. J., whose erection dates back as far as 1681, and which remains, in most cases, in very fair condition. Its dark color, however, has led to a frequent tendency to splitting on the western side of the slabs, *i.e.*, that which faces the afternoon sun. Other materials studied consisted of bluestone, probably from the Catskills, black slate, gray slate, green hydromicaceous schist, and white oolitic

limestone, all in good condition, and white marble, in a decided state of decay.

The artificial methods of trial of stone, now occasionally in vogue, whenever some extraordinary pressure is brought upon architects to pay a little attention to the durability of the material they propose to employ, are, from their obsolete antiquity, imperfection, or absolute inaccuracy, unworthy of the age and of so honorable a profession. They usually consist of trials of solubility in acids, of absorptive power for water, of resistance to frost, tested by the efflorescence of sodium-sulphate, and of resistance to crushing. The latter may have the remotest relationship to the elements of durability in many rocks, and yet is one on which much reliance of the architectural world is now placed. Sooner or later a wide departure will take place from these incomplete and antique methods, in the light of modern discovery.

Reference was made to certain experiments by Prof. J. C Draper on the brownstone and Nova-Scotia stone used in this city, by Dr. Page on a series of the building-stones, and by Profs. J. Henry and W. R. Johnson on American marbles, in some cases with conflicting results, which were probably due to the limited number and methods of the experiments.

V. Means of Protection and Preservation of Stone.

We have here to consider certain natural principles of construction, and then the methods for the artificial preservation of the stone used in buildings. Under the first head, there are four divisions.

Selection of stone. As it is universally agreed that the utmost importance rests upon the original selection of the building-material, it is here that all the resources of lithological science should be called in. Only one investigation, aiming at thorough work, has ever been carried through, that of the Royal Commission appointed for the selection of stone for the Houses of Parliament. But the efforts of these able men were restricted by the little progress made at that time in the general study of rocks, and were afterwards completely thwarted by the discharge of the Committee and by the delivery of the execution of the work of selection to incompetent hands. There will be hereafter, from investigations made in the light of modern researches, no excuse for such annoying results and enormous expenses as those which attended the endless repairs which have been required, since a period of four or five years after the completion of the great building referred to.

Seasoning. The recommendations of Viturvius, 2000 years ago, have been observed at times down to the day of Sir Christopher Wren, who would not accept the stone, which he proposed to use in the erection of St. Paul's Cathedral, in London, until it had lain for three

years, seasoning upon the seashore. Since then little or no attention appears to have been paid to this important requirement by modern architects, in the heedless haste of the energy of the times. Building-stone, even for many notable edifices, is hurried from the quarries into its position in masonry, long before the "quarry-sap" has been permitted, by its evaporation, to produce solid cementation in the interstices of the stone.

Position. The danger of setting up any laminated material on edge, rather than on its natural bedding-plane, has been widely acknowledged; yet it is of the rarest occurrence, in New York City, to observe any attention paid to this rule, except where, from the small size or square form of the blocks of stone employed, it has been really cheapest and most convenient to pile them up on their flat sides.

Form of projections. The principle is maintained by all the best English and French architects that projections (*i.e.*, cornices, sills, lintels, etc.) should be "throated," that is undercut in such a way as to throw off the dripping of rainwater, etc., from the front of the building but in New York this principle is almost universally neglected. It was pointed out that the severity of our climate even requires the further care that the upper surface of projections should be so cut as to prevent the lodgment or long retention of deposits either of rainwater or snow. It is immediately above and below such deposits that the ashlar of our fronts is most rapidly corroded and exfoliated, an effect evidently due mainly to the repeated thawing and solution, freezing and disintegration, which are caused by the water, slush and snow, which rest, often for weeks, upon a window-sill, balcony, cornice, etc. Thus from the initial and inexcusable carelessness in the construction and form of the projections, and, later, the neglect of the houseowner, due to ignorance of the results involved, to remove the deposits of snow, etc., as fast as they accumulate on the projections, is derived a large part of the discoloration of the marble, Nova Scotia stone, or light colored granyte, and especially the exfoliation of the brownstone beneath the window-sills, balconies, etc., by the water alternately trickling down the front and freezing, by day and by night, for long periods.

The artificial means of preservation are of two classes, organic and inorganic. The former depend on the application of some organic substance in a coating or on the injection of fatty matters; but, as the substances are with greater or less rapidity oxidized, dissolved, and carried away by the atmospheric fluids, the methods founded on their use have been properly denounced by many authorities as only costly palliatives, needing frequent repetition, and therefore exerting an influence toward the destruction of delicate carving. The following

were discussed: coal-tar: paint, which has been used in New York for many residences, as in Washington for the Capitol and in London for Buckingham Palace, etc., but lasts only a few years and often even permits the disintegration to progress beneath it: oil, often used in New York, but as objectionable as paint: soap and alum-solution: and paraffine, beeswax, rosin, tallow, etc., dissolved in naphtha, turpentine, camphine, oil, etc.

The preparations of an inorganic nature, which have been proposed and used abroad, have in some cases met with success; but the exact nature of their action, and the conditions to which they are each suited, are yet to be investigated, especially with reference to the entirely different climate by which the stone in our city is being tried. The processes which have been proposed, and in some cases practically used, involve the application of the following substances: waterglass, in connection with salts of calcium or barium, or bitumen: oxalate of aluminium: barium solution, in connection with calcium superphosphate or ferro-silicic acid: copper salts, used by Dr. Robert in Paris to stop the growth of vegetation on stone, etc. There is certainly a call for processes by which, at least, those stones which are used in isolated, exposed, and unnatural positions, may receive artificial protection, such as the stone-sills and lintels of windows, stone balusters, projecting cornices, and ashlar-stone set up on edge. It will doubtless be found that only those stones, which possess a coarse porous texture and strong absorptive power for liquids, will be found particularly available for protection by artificial preservatives, and that such stones should indeed never be used in construction in a raw or crude state. In the spongy brown and light olive free-stones, a marble full of minute crevices, and a cellular fossiliferous limestone, a petrifying liquid may permeate to some depth, close up the pores by its deposits, and encase the stone in solid armor; while, upon a more compact rock, such as a granyte or solid limestone, it can only deposit a shelly crust or enamel, which time may soon peel off. The carelessness with which stone is selected and used, and the ignorance in regard to its proper preservation, when the decay of a poor stone becomes apparent, have led to an increased use of brick and terra cotta, much to be deplored; durable stones are to be obtained in great variety, methods for the preservation of the porous stones can easily be devised, and stones of a fire-proof character do exist in this country in abundance.

In conclusion, three suggestions were offered: 1st, that householders invoke the magic use of the broom on the fronts of their residences as carefully as upon the sidewalks: 2d, that house builders insist upon the undercutting of all projections, and the exclusion of brackets or other

supports to sills and cornices, which only lead to the oozing of water and a line of corrosion down the ashlar: 3d, that house repairers recut the projections in this way, whenever possible, and entirely avoid the use of paint, oil, or other organic preservatives.

February 5, 1883.

REGULAR BUSINESS MEETING.

The President, Dr. J. S. NEWBERRY, in the Chair.

Fifty-five persons present.

The following *Resolution* was passed, "that the New York Academy of Sciences endorse a petition for Congress to remove all duties on specimens of minerals and fossils, whether imported for sale by dealers, or by institutions of learning, or by private collectors, so long as they are intended for cabinet specimens and not for use in the arts."

The following elections took place:

MR. J. W. SMITH of Newark, N. J., as Resident Member.

Marquis ANTONIO DI GREGORIO of Molo, Palermo, Sicily, as Corresponding Member.

Mr. W. E. HIDDEN exhibited nuggets of gold from Burke Co., N. C., from ten to fifty pennyweights in weight, an extraordinary size for that region. They were found in superficial deposits, and had evidently not traveled far.

MR. ROMYN HITCHCOCK read a paper entitled:

THE RETICULATE STRUCTURE OF LIVING MATTER (Bioplasson), with exhibition under the microscope of blood corpuscles and amœbæ, showing granular in place of reticulated structures, of corpuscles of blood and pus treated by potassium dichromate, and of the resolution of the lines, $\frac{1}{95000}$ of an inch apart, upon the diatom, *amphipleura pellucida.*

(Abstract).

The living matter of plants and animals, from the lowest prototype to the highest form of animal life, is, so far as our knowledge extends, identical. It is variously named protoplasm, bioplasm, sarcode, and, not having a sufficient number of names, still another has been applied to it—bioplasson—and a new hypothesis of the structure of living matter, termed the "bioplasson theory," has recently been put

forward and upheld in this country, mainly by Drs. Carl Heitzmann and Louis Elsberg. It is of this so-called theory, which at the most is merely a hypothesis, that I desire to speak this evening. I shall rely upon ocular proof to show that there is no reticulum in the blood cells.

The microscope, like every other instrument of research, requires to be manipulated by a person of experience, to yield trustworthy and the most perfect results. Yet there is a vast difference between the ability to manipulate it and the ability to see what it reveals. Perhaps only a small proportion of this audience could use the instrument fairly well; yet I doubt if there is one person here who could not see the most minute details of any object, after the proper adjustments have been made.

We may consistently confine the discussion to three objects, viz., the *amœba*, and the red and the white blood-corpuscles. As those who have heard Dr. Elsberg's remarks before the Academy know very well, the theory is, essentially, that all living tissues are constituted of a fine net-work of very contractile, living matter, with inert matter filling the meshes. It is not necessary to explain the theory more at length, for the reason that the existence of such a net-work, readily seen by the aid of a microscope, forms the foundation of every observation in support of it. Moreover, as the reticulum is said to be clearly visible in all living matter, we have only to prove either that it does or does not exist in the *amœba*, or in a white blood-corpuscle, to sustain, or to utterly refute the theory.

I propose to demonstrate that there is absolutely no trace of such a net-work in a blood-corpuscle. When the object-glass is properly corrected and focused, no reticulum whatever can be seen. In other words, the apparent reticulum which Dr. Heitzmann shows is, undoubtedly, the result of faulty observation of some kind; but probably the faults are not of a kind that a student or inexperienced microscopist would be able to detect, or to point out with any assurance. It is said that the movements of a homogeneous jelly, such as protoplasm has been described to be, would be impossible—that some kind of reticulated structure is necessary to enable us to explain its power of movement. At present it is merely a question of fact whether there is a reticulum or not. After its existence has been demonstrated it will be time enough to theorize how it enables us to understand the phenomena of life.

The reticulum is supposed to explain the movement of living matter; movement is due to contractility; the contractility resides in the nodes and connecting threads of the net-work; the extension or contraction of the net-work explains the movement of the *amœba* and the blood-cell. It is an ingenious, mechanical explanation of a mystery that has

puzzled the scientific world for ages. All the motions of life are due to the contraction and expansion of a reticulate structure, which is common to all living things. How easily all the observed facts are explained! What an admirable machine the *amœba* is! Perhaps somebody will ask, by what means the reticulum itself is enabled to extend and contract. I am not aware that any effort has yet been made to solve this problem. Enough, that the movements we see are explained upon mechanical principles. Like the thousands of persons who are satisfied to understand mesmerism as animal magnetism, and strange phenomena as due to electricity in the air, these gentlemen present, in the name of science, an explanation that does not explain.

The sources of error in microscopical observation are: 1. Improper illlumination. 2. Imperfect correction of the objectives. 3. Incorrect focussing. The first source of error does not concern us in the case under consideration, for no special niceties of illumination are required. The second is of more consequence; but, in order to eliminate it from my own observations, I have used objectives which were either adjusted by the makers and set in fixed mountings, so that their corrections could not be changed, or else I have adjusted the lenses myself by the use of suitable objectives, so that their correction was as perfect as possible. Finally, errors of focussing alone remain as the only ones which cannot be absolutely eliminated. Yet these, in the special objects of study, the *amœba* and the blood-cells, are of no consequence whatever; for no experienced observer can be in doubt as to the exact focus for a white blood-corpuscle.

A few words now about the appearance of blood-corpuscles when highly magnified. The red corpuscles, when examined in the serum, are double concave disks. When lying flat, in the focus of a good objective, they appear to be quite homogeneous in structure; the central portion of the disk, owing to the concave shape, appearing slightly darker than the rest. I am not aware that it is claimed that a reticulum can be seen in the red corpuscles under such circumstances. To demonstrate the net-work, it is necessary to use some reagent, and a saturated solution of potassic bichromate, diluted with about an equal volume of water, is recommended for the purpose. The addition of such a solution to fresh blood produces a great change in the appearance of the corpuscles. They become granular, and some of them undergo slow changes of form, budding, etc., as Dr. Heitzmann has described in his book, recently published. When the corpuscles begin to become granular, there is a time when they present an appearance of reticulation. But careful observation with high-powers fails to show any connecting net-work. There is nothing but a breaking up of the

contents into separate granules; and, as the action of the reagent continues, the granules become more distinct, uutil they can be very clearly defined by a good objective.

It is a fact well known to observers with the microscope, that any body, regularly marked with fine and close dots, can be made to appear as though covered with fine, continuous lines. The dots merge into each other and form lines in the image. Thus, in the diatom, *pleurosigma angulatum*, an inferior objective will show the markings as fine, distinct lines, but a better lens will resolve the lines into rows of dots, a fact familiar to every microscopist. It is doubtless owing to this that the granular structure of protoplasm has been taken for a reticulum.

I believe the strongest and the most convincing argument, against this bioplasson doctrine, is the fact that the reticulum, which these gentlemen declare is so readily observed, has hitherto entirely escaped the notice of the best histologists in the world. Dr. Heitzmann has used these words: "Take a drop of pus, fresh, without adding anything, and you will see the wonderful structure in each pus-corpuscle *with great ease.*"

I will ask if it is reasonable to suppose that a structure, that can be seen "with great ease," could have been overlooked by such men as Beale, Balfour, Carpenter, Frey, Bütschli, and a host of other equally competent observers, and reserved for an individual of to-day to discover. Yet this is what Dr. Heitzmann declares he has discovered, and upon this discovery he has built up a totally new and comprehensive theory of the structure, not only of living matter, but of the whole living world, connecting all the different tissues of the animal and vegetable body through this reticulum, and utterly discarding the cell-doctrine, which has rendered such excellent service to science for thirty years. To an experienced microscopist the idea seems preposterous. The objects most familiar to the histologist and pathologist, coming almost daily under the eye of the physician who uses the microscope in his practice, are now declared to possess a distinctly reticulate structure, never before even dreamed of.

DISCUSSION.

The CHAIRMAN enquired whether it had been established that the motions of the amœbæ were dependent on cilia or otherwise.

Mr. HITCHCOCK replied that at present there is no evidence nor knowledge of the structure of the amœbæ; indeed, they appear to be absolutely without visible structure.

Dr. L. SCHOENEY remarked that to see or not to see is the real question in regard to structure. More stress, however, is now laid upon

the interpretation than on the supposed reticulum itself. In regard to the first, *i.e., seeing reticular structure*, the verdict of independent microscopists has, in the majority of cases, been unfavorable. The best authorities among those gentlemen have discussed and contested it. That which is described by the founder of this doctrine, as threads of a network, appears under the best objectives, well focussed, as a mass of granules, irregularly heaped, more or less approaching each other, and here and there leaving interstices; but nothing is seen which would mark a distinction between mere granules, distinctly attached to each other, and a homogeneous line of thread. At the locomotion of an amœba, the granules within flow along, more or less adherent to each other, as globules of blood are seen to flow, attached to each other, during circulation—nothing more.

In regard to discrepancies in observation with the microscope, we may be permitted to refer here to the most remarkable discovery recently made in optics by Prof. Abbe, which may throw light in the future on many errors of observation with the microscope. Prof. Abbe distinguishes two kinds of microscopic vision: one like the ordinary vision, by rays directly from the object to the eye, which he calls *dioptric image:* the other, *diffractive image*, produced by rays that travel around the edge of a line or a minute object, so fine as to be but a small multiple of a wave-length of light. These images are formed by recomposition of the spectra, produced by these fine lines of objects. They are less than 1-3000 of an inch. Since these granules are smaller, the apparent blurred lines or threads are only diffractive images of granules. This would account for some objective errors. But are there not also some subjective, personal errors, to be accounted for in microscopy, as there exist in her sister science, telescopy—if astronomy may be so termed, by analogy. We know astronomers have to allow for personal equation, errors owing to the difference in time between the impression on the retina and the record by speaking or drawing, in different observers. May not microscopists be distinguished by individual delicacies of vision? Moreover there are other subjective errors, individual anomalies, to be accounted for.

The fine pictures of Turner's, notwithstanding their beauty, have encountered much severe criticism. In fact it has been ascertained by Liebreich, who carefully examined Turner's gallery, that the painter was affected by astigmatism, producing oddities in color and chiefly in perspective, which formed the incongruities in his art. So, too, the great physicists of the future will doubtless determine the personal errors of one nature or another, which have attended the labors of former workers with the microscope. So much for the wondrous network itself.

But far more important is its supposed mode of motion. If we attempt to analyze the elements of this reticulum, in order to demonstrate by it the motion of living matter, even the *primum movens* of muscular fibre, we have to imagine one mesh of this network as a rhombus or a triangle, whose sides have granules at their angles, and which are impelled forward by the contraction of the sides, acting in the diagonal of a parallelogram of forces, of which these sides represent two. We have to deal, in the first place, with two forces instead of one, which we wish to define, and withal forces similar to the one to be defined. We are reasoning in a circle. The syllogism includes the postulate of contractility of the elements of the reticulum. To demonstrate in this way the contractility of muscular fibre is a *a demonstratio ad absurdum.*

The importance of this controversy cannot be overrated, if we consider that the question of the motion of protoplasm involves the highest reflection in regard to the origin of life—the *primum movens vitæ.*

Dr. L.S. BEALE, in the last edition of his great work on protoplasm, has an appendix, in which he treats upon the influence which this conception of vital motion exerts on the highest fundamental truths of Christianity. In this he discusses the connection between protoplasm and the machinery of the motion of life. If living matter has a mode of motion, this must be analogous to other modes produced by cosmic forces, or it must be peculiar and unique. But even if—as some suggest—living force and motion are evoluted from other inorganic or cosmic forces, we are, at the present state of physical science, where all the different wave and vortex motions are not at all yet determined, far from being able to venture a hypothesis on the mode of motion of living matter. Until then, we must content ourselves with the distant analogy, looking up to those stars that possess their given motion in their own centre, and applying the same inherent individual force, given to the simplest unit of organic matter, whether in the brain-cell (Hœckel's *soul*) of human beings, or in the lump of protoplasm dredged up from the bottom of the ocean; and observing it to move of itself, we exclaim "*de profundis.*"

Mr. A. H. ELLIOTT referred to the experiments of Dr. Crookes on "radiant matter," and enquired whether there were any means of explanation of the motion of the granules of living matter analogous to the molecular motion observed by that investigator.

Dr. SCHOENEY remarked that mere molecular motions were simply helped or retarded by the different physical forces, but that the

agencies concerned in the phenomena of life were quite different from the other cosmic forces.

Mr. HITCHCOCK stated that it had been suggested, in regard to the distinction between living and non-living matter, that they may differ in the same way, as in inorganic bodies, atoms of the same substance are subject to different arrangements--one mode of arrangement being peculiar to living matter.

Mr. GEORGE F. N. KUNZ then exhibited specimens of the blue amber from Catania, on the coast of Sicily, and a mass, three-fourths of a pound in weight, of a very good amber color, and partly covered with recent bryozoa, from the Tertiary deposits of Nantucket, Mass. He also read a paper:

ON A LARGE MASS OF CRETACEOUS AMBER FROM GLOUCESTER COUNTY, NEW JERSEY.

(Abstract).

About twelve months ago, a mass of amber of uncommon size and form, (being twenty inches long, six inches wide, and one inch thick, weighing sixty-four ounces) was found at Kirby's marl pit, on Old Man's creek, near Harrisonville, Gloucester Co., N. J. A quarter-inch section showed a light greyish-yellow color. A section one and one-quarter of an inch thick showed a light yellowish-brown color. The entire mass (surface and interior) contained botryoidal shaped cavities, filled with glauconite, or green sand, and a trace of vivianite. The hardness is the same as that of the Baltic amber; but it is slightly tougher, and cuts more like horn, the cut surface showing a curious pearly lustre, differing in this respect from any other amber I have yet examined. This lustre is not produced by the impurities, for the clearest parts show it best. It takes a very good polish. The specific gravity of a piece of carefully selected amber is 1.061, and is the lowest density on record; the usual range being from 1.065 to 1.081. It was found at a depth of twenty-eight feet, covered with twenty feet of green sand or marl, in a six foot stratum of fossils, consisting mostly of *Gryphea vesicularis*, *Gryphea Pitcheri*, *Terebratula Harlani*, and others. The upper part of the marl consists of a layer of limestone, several feet in thickness, filled with *Palorthis*, echinoid spines, and an occasional shark's tooth of the genus *Lamna*, and this covered by eight feet of earth. The marl belongs to the middle bed of the Upper Cretaceous series.

No analysis has as yet been made of this amber, but the similarity of the specific gravity, the hardness, and the ignition, leave little

doubt of its being a true amber, very closely resembling the Baltic and other ambers.

DISCUSSION.

Dr. N. L. BRITTON enquired whether any lignite had been found with the amber. The Middle marl-bed was about a mile distant, and contained lignite. Also, in the clays of the Raritan river, a lignite-bed of coniferous wood occurred, containing many small pieces of fossil gum, one inch or so in length.

A MEMBER suggested that the identity of these fossil resins, from this and other American localities, with true amber, had not yet been established, no analyses ever having yet been made, to his knowledge, to determine the presence or predominance of succinic acid.

Prof. D. S. MARTIN remarked that it is a curious and interesting fact that the hardness of fossil resius, as a rule, increases with their age. Thus true Tertiary amber is much harder than the later Copals, etc., yet still it is easily cut and carved; while, in the lower beds of the Cretaceous, the amber is brittle and difficult to work.

Mr. W. E. HIDDEN stated that amber had been found last summer in the marl-beds of North Carolina, and the specimens were now deposited in the Geological Museum at Raleigh.

Dr. B. N. MARTIN had heard the well-known worker in amber in this city, Mr. Kaldenberg, remark that the largest specimen of amber he had ever seen was one from New Jersey, "found on the shore of Raritan Bay," and now deposited in the museum at Berlin, Germany.

Mr. KUNZ was not aware of any analyses of the New Jersey specimens, but pointed out that they possessed the specific gravity, hardness and general physical properties of true amber. In fact, there was now great danger of making too many species in mineralogical determinations.

The CHAIRMAN observed that it was remarkable that amber was found in so few places in any large quantity, such as occurred on the shores of the Baltic. The fossilgums introduced into commerce, *e.g.*, kauri, copal, etc., were all resins of different and generally known trees, but that of the Baltic—yellow, hard and aromatic—belonged to an an older formation. At present, there was a

considerable number of coniferous trees which yielded resins. In the clay-beds, underlying this locality in Gloucester County, N. J., a great number of coniferous trees had been found, of remarkable beauty and interest, all differing from the conifers found elsewhere, and their resins must be different. This fossil gum therefore does not deserve to be called by the same name as that of the Baltic. In one pit a whole barrelful had been found and burned by the workmen. From Japan also a resin had been brought, called amber, upon which there were impressions of leaves (*Sequoia*).

February 12, 1883.

SECTION OF GEOLOGY.

The President, Dr. J. S. NEWBERRY, in the Chair.

Forty-one persons present.

The CHAIRMAN called attention to the specimens of coal, exhibited by Mr. McDonald, from the Brier Hill seam at Massilon, Ohio, in the lower beds of the Carboniferous The material consisted of thin alternations of bright and lustreless laminæ, the latter forming partitions by which the bituminous matter was shut up in cells and thus prevented from melting together when used as fuel. As it does not cake nor agglutinate, it is the finest grate-fuel in the world. It is found in local basins of limited extent, corresponding, in origin and general features, to the peat-marshes now found in the same region, and which have sometimes filled up a deep cañon or valley to the depth of fifty feet or more.

Mr. MCDONALD stated that the beds of coal appear to occupy great elongated basins, trending about ten degrees east of south or west of north, seldom exceeding five feet in thickness and thinning out at the edges. This basin embraces about one hundred acres of workable coal, from two and a half to five feet in thickness. The stratum is the lowest of the series, and is largely made up of detached basins, which are from ten to one hundred and fifty acres in extent.

The CHAIRMAN explained that the elongated form and trend of these basins was due to the excavation of the containing valleys by the ancient streams, which then as now must have, in general

flowed southward from Lake Erie and Northern Ohio. Many were sluggish and became elongated peat-marshes. A submergence of this area, and the deposit of gravel and sand upon the marshes, would naturally produce such basin-like masses of coal.

A paper was read by Mr. B. B. CHAMBERLIN, with an exhibition of a large number of specimens, on

THE MINERALS OF THE WEEHAWKEN TUNNEL.

(Abstract).

The Palisade range, with its continuation southward, is a vast storehouse of minerals, increasing in quantity and quality with the depths from which they are obtained.

The question, "Why has the Weehawken tunnel yielded less plentifully than the tunnels west of Hoboken?" is partially explained by one fact, that it does not lie as far beneath the surface of the ground as the other tunnels, save in one portion of its course.

This section, nearest the Hudson, embracing shafts numbers 1 and 2, has proved fully as prolific of mineral trophies as an equal space in the tunnels below, where no less than six shafts in each received the attentions of collectors of the prized zeolites.

Most of the usual list of this class of minerals, obtainable in our vicinity, appeared in greater or less quantity at Weehawken, a description of which is here given:

Pectolite.—Weehawken tunnel has furnished science with perhaps some of the finest crystalline forms yet discovered.

A curious feature of much of the Weehawken pectolite consists in the numerous clefts and fissures, as though made by a knife or saw, an explanation of which is perhaps yet to be given.

Datolite.—This mineral, so common in the other tunnels of the ridge, here appears in very limited quantity. These few specimens are characterized by great brilliancy and beauty. The color is a delicate green, considerably lighter than usual in specimens from this vicinity.

Analcime.—The specimens of analcime are quite showy as cabinet specimens, and superior to those found elsewhere along the ridge.

The crystals are rarely over half an inch in diameter, in color often snow-white. Many present curious depressions on certain faces of the crystals.

Prehnite.—Much of the prehnite here found was intimately associated with an inferior quality of natrolite and pectolite, quite unattractive to a collector. Two or three small bits of green incrustation, some-

what paler than the ideal tint, are all which my cabinet contains to represent this noted mineral in this locality.

Calcite.—Many of the calcite specimens are peculiar to the locality.

The prevailing form is the scalenohedron, with a great variety of changes, sometimes carried to such an extent as to present rounded surfaces of great beauty. Compound groups and twinned crystals are unusually numerous. Forms highly modified are symmetrically associated with others equally interesting—varying in color as well as in shape.

Natrolite.—Seldom has this highly prized mineral appeared in greater abundance than at Weehawken. Between Shafts Nos. 1 and 2, large spaces of rock were coated with the mineral. The workmen gave glowing accounts of a blast, which released a block of stone "as large as a cooking-stove," one surface of which was white with natrolite—in some places finely rosetted. The stone was broken into sections and fragments, and carried away for disposal to collectors. One of the most interesting of these specimens is about eight inches square, supporting some twenty rosettes in fine condition. Incrustations of interlaced crystals, resembling cocoanut candy, several inches square and of a snowy whiteness, are among the specimens offered on this occasion. At other times, the acicular variety appeared in considerable quantity. An outburst of flowing water unfortunately injured a mass of the most promising material. Specimens from other cavities resemble snow-white plush. Aggregations of a globular form are among the most charming trophies the tunnel has yielded, especially when mounted on a surface of cream-colored stilbite.

Apophyllite.—Weehawken claims the honor of affording the first discovered pink apophyllite in the United States. The crystalline forms are generally simple. In size, some are an inch in length. In a few cases crystals are finely striated, the terminations vanishing into smaller crystals—a profusion of which cover the surface of the gangue. Interesting also are cases where opaque pinkish crystals present transparent terminations. Some few choice crystals of the usual color appeared, among them the glassy variety. In a drusy form, the mineral was quite as plentiful as datolite proved to be, in the tunnels back of Hoboken.

Amethyst.—Of interest to a local collector are the fragments of a lavender-colored amethyst, associated with the pink apophyllite of Shaft No. 1.

Stilbite.—The stilbite found varies in tint, from a snow-white to cream color and light brown.

The only other zeolite to be referred to is *Laumontite*, of which there appeared a few unimportant fragments. I have met no trace of chaba-

zite or its relative, gmelinite. Some good bits of *Blende* are worthy of preservation.

No allusion need be made to thomsonite, unless the name be applied to certain mysterious specimens, the nature of which has not yet been determined. The crystals are acicular, of remarkable length, radiating from a globular nucleus of considerable hardness.

Pyrite, in brilliant and finely modified crystals, was brought out plentifully from Shaft No. 1. Some of the finest of these were half an inch in diameter.

The subject was further discussed by Mr. KUNZ and the Chairman.

DR. JOHN S. NEWBERRY then read the concluding part of his paper on

THE BOTANY AND GEOLOGY OF THE COUNTRY BORDERING THE RIO GRANDE, IN TEXAS AND CHIHUAHUA.

(Abstract).

Having recently spent some time in Southern Texas and Eastern Chihuahua, a country until recently overrun by the Comanches and Lepans, and, hence, but imperfectly known, I venture to hope that a few words of description of its aspects, geological structure, botany and resources, may not be unwelcome, especially as the attention of our people is being drawn in that direction, since it offers a new field for our surplus population and for the investment of capital.

The eastern and central portions of Texas are so well known, as to require no detailed description. Near the Gulf, the climate is warm and moist, and sugar and cotton are successfully raised. Beyond this belt, we pass on to plains on which there is little timber but mesquite, but the surface is covered with rich grass, and it is already one of the most productive grazing districts of the United States. The underlying rocks are, for the most part, of the cretaceous formation, without useful minerals, and the climate is dry.

On the western side of these plains, the country is traversed by mountain-chains, which belong to the Rocky Mountain system, and which form the outer rim to a region, of which the topography is more varied, the mineral resources greater, and the agricultural capabilities less, than those of central or eastern Texas. This is, in fact, part of a great table-land, that fills the interval between the eastern and western mountain ranges, here nearly a thousand miles apart, and which extends with diminished breadth, southward throughout the central portion of Mexico. The Rio Grande has cut deeply into this plateau, and, where it has forced its way through the mountains that

form its eastern rim, has excavated a series of deep and rocky cañons, which are impassable by boats and rival in their wild scenery those of the Colorado of the West. The country, immediately bordering the river, is much broken, but north and south there are intervals between the numerous and disconnected mountain-ranges, which are grassy plains, presenting on a smaller scale the features of the Llano Estacado on the north, and the Bolson de Mapimi on the south.

Further west, we reach a still more broken and arid country, in New Mexico, Arizona, Chihuahua and Sonora, where the ragged outlines of the mountains, and the peculiar vegetation—mostly cactus—give a special aspect to the scenery. This latter country, the home of the Apaches, has been the theatre of active mining operations, for many years, and the scene of unnumbered bloody tragedies. The country lying within southwestern Texas, eastern Chihuahua and western Coahuila, less rich in gold and silver, seems not to have proved sufficiently attractive to the Mexicans to induce them to brave the danger of its occupation, and it has been not only unoccupied, but much of it unexplored. The line of the Mexican Central Railway, which is being pushed southward from El Paso to the City of Mexico, passes about 200 miles west of the belt of country referred to; and the railway which crosses the Rio Grande at Laredo, and is now extended southwest to Monterey and Saltillo, is about as far away on the east. A concession has been granted by the Mexican Government to European capitalists, to build a road from Presidio del Norte, or Eagle Pass, or both, to Topolovampo, on the Gulf of California, and this road will probably traverse, almost centrally, the district under consideration. The general altitude of this country is from 4000 to 5000 feet, the Rio Grande, as it passes through it, falling from 3000 to 1000 feet above the sea level.

BOTANY.

The country bordering the Rio Grande, in Chihuahua and Texas, is nearly destitute of trees, a feature which marks the aridity of the climate; yet, in certain localities, as on the bottom lands of the Rio Grande and Rio Concho, a vigorous and somewhat varied forest-growth was found at the advent of the whites. No better illustration of the relation between the kind of vegetation and the water supply in a country can be found, than that afforded by the luxuriant growth of trees of several kinds along the Cibola in the Chinati Mountains, Texas; while on all sides this oasis is surrounded by an apparently boundless, grass-covered prairie, where the rain-fall is inadequate for trees. On the mountain-summits, south of the Rio Grande, is a sparse growth of piñon (*Pinus edulis*), and evergreen oak, (*Quercus Emoryi*). The

low lands, in certain localities over thousands of acres, are thickly set with mesquite, (*Prozopis glandulosa*), here a strong spreading shrub, never a tree, but with roots disproportionately large, composed of very dense tissue and furnishing a large amount of excellent fuel. Along the arroyos, cottonwood may occasionally be seen, either the narrow or the broad-leaved forms, (*Populus monolifera* or *P. angustifolia*), and more commonly the hacksberry, (*Celtis occidentalis*), and the nogal, the little black walnut (*Juglans rupestris*), the Mexican Buckeye (*Ungnadia speciosa*), and the Guyacon (*Guyacum Coulteri*). The dryer portions, especially the gravel terraces bordering the Rio Grande, are frequently covered with the creosote plant, (*Larrea Mexicana*) and *Tonquieria splendens*. The latter forms a cluster of fifteen or twenty canes, ten or twelve feet high, springing from the same root, and bristling with spines, an inch or more in length, of which the bases are in contact. Usually it is without leaves, and seems as though dead, but, for a brief interval in the rainy season, it is covered with small crowded obovate leaves, and from the summits of each stem springs one or more spikes of brilliant crimson flowers.

Among the shrubs which form the "chapparal" or thickets, the *Holacantha* is the most conspicuous, and *Salizaria* the most interesting. The former, as its name implies, is a mass of thorns which are often as large and strong as those of the honey locust. The branches and spines are covered with a green epidermis, which performs the functions of leaves, and, in the spring, these bear bunches of yellow flowers similar to those of *Berberis*. The *Salizaria* is a labiate allied to *Scutillaria*, and the seed is enclosed in a balloon-like capsule, similar to that of the balloon vine (*Cardioz permum*), also found here and having the same function, namely, dissemination by the wind. Two species of *Acacia* and one of *Berberis*, (*B. trifoliata*) all spiry, help to make the chapparal as nearly impenetrable as the thickets of cactus further west. We are here fairly within the confines of the cactus country, but not in its heart. Many species differing much in habit are constantly in sight—the "nopal," an *Opuntia*, being the most common, one species growing in a mass ten feet or more in height, with each leaf-like subdivision of the stem a foot in diameter. Though covered with spines, this plant is largely eaten by cattle, and nothing is more common than to see a patch of it trampled down, half eaten, and the flattened stems notched by their semi-circular bites. One species or variety of *Opuntia*, growing abundantly in Chihuahua, is of a deep purple color, which makes it conspicuous and often ornamental.

The most striking feature in the botany of this region is formed by the century plant and its allies: other species of *Agave*, *Habranthus*,

and *Dasylirion*, and the yuccas. In many places these are the only plants attaining any large size, and are very numerous, scattered over the plains, and slopes of the mountains; the plants not crowded, but separated by intervals of a few feet, which are occupied with a luxuriant growth of gramma grass. The yuccas belong to four species or three species and two varieties, *Yucca angustifolia* and *Y. vaccata*. Of these, two rise to the height of five to fifteen feet, with trunks from six to twelve inches in diameter, the crowded radiating leaves crowning the summit in a round or oval mass, six feet or more in diameter, the old leaves hanging perpendicularly and forming a peculiar thatch around the trunk and extending to the ground.

The century plant is, in Chihuahua, represented by a variety with shorter and broader leaves than that commonly cultivated. From the center of the tuft, the flower stalk rises from 10 to 25 feet in height, composed of woody tissue and standing some years after bearing flowers. These persistent flower-stalks, crowning the ridges and visible for miles, give a peculiar aspect to the scenery. The century plants are, however, nowhere as numerous as the species of *Dasylirion*, with which they are associated, and which do not die with the effort of florescence. Further south, the agave supplies, from its sweet juice, the material from which an intoxicating drink is produced. In this region, however, an alcoholic beverage is obtained from the "Sotol" (*Dasylirion Texamum*), which, from its abundance and the use made of it, deserves a prominent place among the economical plants of the country. Hundreds of thousands of acres are covered with this Sotol, and it would seem that it might be much more largely utilized than it is, for the manufacture of alcohol. The leaves are three to three and a half feet long, by one and a half inches wide at the base, straight, flat and garnished on either side by strong recurved hooks. The color is yellow green, and the leaves are very numerous. From the center rises, at a certain stage of growth, a woody flower-stalk, ten feet high and at the base as large as one's arm. The trunk rises but a few inches above the ground and is completely concealed. The top of this trunk, composed of the closely imbricated leaf-bases, which are broad, yellow, shining, succulent and sweet—with a pulpy mass at the center, containing much saccharine matter, raw, or better roasted, is palatable and nutritious; so much so, that in the country where it grows, it is said the Indians never really suffer for want of food, as this affords them an abundant if not varied aliment.

In the preparation of Sotol whiskey—a liquid called *mescal*, as is also that made further west from other plants, the portion of the plant which has been described is trimmed so as to resemble a head of cabbage, then roasted and fermented, the product of the vinous fermentation being

distilled in the ordinary way. For roasting the Sotol, a pit is dug, some ten feet in diameter and four feet deep, lined with rude masonry. In this a fire is built, and when it has been burned down, the pit is filled with several hundred Sotol heads. When roasted, they are chopped in pieces and fermented in vats.

Another interesting plant, the companion of the Sotol, is the "Lechuguilla," (*Agave heterocantha*), of which the leaves furnish a strong fibre, universally employed for ropes, sacks, etc., in Northern Mexico. This grows on the mountain slopes, generally at an elevation of about 4000 to 5000 feet, is common in all northern Chihuahua, and especially abundant on the Chinati Mountains in Texas.

GEOLOGY.

The prevailing rocks of Chihuahua and Texas, are cretaceous sediments, chiefly limestones, broken through at frequent intervals by eruptions of trap of various kinds, trachyte, porphyry, diorite, etc. Presidio del Norte is surrounded by mountains, partly eruptive, partly upheaved sediments, with open intervals between them, occupied by the cretaceous strata, generally much disturbed. Between Presidio and the Sierra Rica, the middle and upper cretaceous rocks prevail—apparently the Colorado and Laramie Groups, the lower shales with bands of calcareous concretions filled with fossils, the upper sandstones and shales containing impressions of plants and thin coal. The concretions referred to above contain immense numbers of well defined cretaceous fossils, consisting of *Ammonites*, *Nautilus*, *Helicoceras*, *Ptychoceras*, *Baculites*, *Gryphea*, *Ostrea*, *Inoceramus*, etc. The Colorado shales here are very black, though much metamorphosed, and containing *Inoceramus*, form the walls of the vein of the Sierra Rica mine, a clean cut fissure, crossing the bedding of the shales nearly at right angles, having a quartz gangue, containing some very rich but very compound ore, copper, zinc, lead, silver and iron.

Seventy-five miles southeast from Presidio are the San Carlos Mountains, composed of cretaceous limestones set at a high angle and very much metamorphosed. The San Carlos cañon cuts through the greater part of the range, showing a section of several thousand feet of rock, mostly light blue, but sometimes black limestones highly metamorphosed, yet often crowded with characteristic cretaceous fossils.

The ore deposit at the San Carlos mine is of extraordinary magnitude and of special interest. It fills a series of chambers in limestone, one of which is several hundred feet in length and more than 200 feet in depth and breadth. It is evidently a chemical deposit, filling cavities made by solution, and consists of black, often crystalline magnetite, pyrites, galena, and blende, containing both gold and silver. Of

this ore there are apparently many millions of tons, and in character it is, so far as I know, without parallel among all the ore deposits of the country. At a distance of half a mile, the limestones are cut through by a great dyke of diorite, which has doubtless furnished the heat that was the mainspring of the chemical affinities, but it has apparently contributed nothing to the mineral matter of the ore deposit. At a point further south, the dyke crosses the zone of limestone which holds the ore. It is there metamorphosed, but not at all mineralized.

In the same region are other mineral deposits, which will probably prove to be of considerable value. Among these is another series of chambers in limestone, filled with hard carbonate of lead and galena. Others still, which are rich in copper, also carry silver and gold.

February 19, 1883.

LECTURE EVENING.

The President, Dr. J. S. NEWBERRY, in the Chair.

The large Hall was occupied by the audience.

Dr. ALBERT R. LEEDS, of Stevens' Institute, Hoboken, delivered a lecture on

HEALTH-FOODS, INVALID-FOODS, AND INFANT-FOODS,

illustrated by an analytical table and a series of specimens.

February 26, 1883.

ANNUAL MEETING.

The President, Dr. J. S. NEWBERRY, in the Chair.

The CORRESPONDING SECRETARY reported as follows:

"During the past year, six names have been added to our list of Corresponding Members. The Academy has suffered the loss of two eminent Honorary Members, Charles Darwin and Friedrich Wöhler. The vacancy caused by the death of the former has been filled by the election of Major-General Sir Henry Creswicke Rawlinson; that by the latter has not yet been filled.

ALBERT R. LEEDS,
Corresponding Secretary."

From the book of the TREASURER, the EDITOR has compiled the following statement, for the year ending February 26, 1883:

Receipts.

Initiation Fees.

Feb., 1882, to Feb., 1883, fees of 17 new members.....		$85.00

Annual Dues.

Feb., 1882, to Feb., 1883, 276 dues and back dues.....		1,380.00

Subscriptions to Annals.

Feb. 27, 1882, to Jan., 1883, 134 annual subscriptions..	$268.00	
Sales of annals and transactions, per D. S. Martin...	53.72	
		321.72

Interest on Bonds.

1882. April 1, July 1, Oct. 2, and Jan. 1, 1883.....		164.00

Sundry.

1882.	Feb. 9.	A. J. Todd, donation for transactions	$25.00
	" 12.	C. S. Fisher, " " "	15.00
	Apr. 10.	G. M. Beard, rent of hall.....	13.50
			53.50
	Total receipts		$2,004.22

Expenditures.

1882.	Feb. 27.	Amount advanced by Treasurer.....		$202.19

Treasurer.

1882.	Apr. 28.	Gregory Bros., printing receipts, etc.	$6.50	
	Sept. 14.	G. P. Putnam's Sons, printing memorandum of fees.....	7.25	
1883.	Jan. 17.	J. Cornelssen, collection of fees.....	93.20	
	Feb. 7.	J. H. Hinton, postage and stationery	20.00	
				126.95

Recording Secretary.

1882.	Feb. 27.	O. P. Hubbard, postage, etc.....	$5.14	
	Nov. 16.	C. H. Clayton, minute book.....	3.75	
				8.89

Library.

1882.	Mar. 7.	A. Woodward, services in library..	$22.83	
	Apr. 15.	T. Egleston, postage.....	25.00	
	Nov. 3.	B. Westermann & Co., importation charges	6.65	
	" 9.	C. G. & F. Neumann, bookbinding.	100.10	
	" 9.	" " " .	130.00	
	" 29.	A. Woodward, services in library..	17.75	
				302.33

Annals.

1882.	May 4.	B. B. Chamberlin, engraving maps, etc.	17.00	
	" 8.	Gregory Bros., printing Annals, II, Nos. 7 and 8	227.61	
	" 11.	D. S. Martin, services as editor of Annals	100.00	
	July 15.	G. Gregory, printing Annals, II, No. 9	128.93	
				473.54

Transactions.

1882.	Dec. 4.	A. A. Julien, bills paid for printing.	100.00	
1883.	Feb. 13.	The Spectator Co., printing	50.00	
				150.00

Lectures.

1882.	Apr. 10.	J. S. Newberry, lecture expenses	5.00	
	June 20.	A. H. Elliott, " "	11.50	
				16.50

Weekly Meetings.

1882.	Feb. 27.	D. S. Martin, postal cards, etc.	55.73	
	Apr, 4.	" " "	12.10	
	May 8.	Gregory Bros., printing ballot-cards, etc.	50.75	
	July 15.	G. Gregory, printing	20.25	
	Nov. 3.	D. S. Martin, postal cards, etc.	37.92	
				176.75

General Expenses.

1882.	Apr. 10.	J. S. Newberry, postage, etc.	10.18	
	May 13.	Hussey's Post, delivery of notices	17.74	
	Nov. 25.	L. R. Weeks, addressing notices, annals, etc.	61.59	
				89.51

Rent of Rooms.

1882.	May 12.	N. Y. Academy of Medicine	118.75	
	Sept. 26.	" " "	106.25	
	Nov. 3.	" " "	106.25	
1883.	Feb. 7.	" " "	106.25	
				437.50

Total expenses $1,984.16

February 26, 1883, Balance on hand $20.06

The Recording Secretary reported as follows:

"The annual meeting was held Feb. 27, 1882, when the officers of the Academy were elected and the ordinary business was transacted.

There have been nine sessions of the Council and thirty-four meetings of the Academy—fifteen before the summer recess and nineteen since.

The Proceedings of the Academy are well-known to the members.

The attendance on the regular meetings is unchanged, and that on the lectures indicates a high appreciation of their value.

The communications, oral and written, have been numerous and very varied. They have been fully illustrated by specimens, instruments, diagrams and the lantern, and may be classed as follows:

Arts	3	Geology	15
Archæology	1	Mineralogy	22
Astronomy	2	Nat. History	12
Chemistry	8	Psychology	2
Engineering	2	Physiology	4
Total			71

Nine lectures have been given by members and other gentlemen, on invitation of the Academy—on Archæology, Chemistry, Geology, Physiology and Zoölogy, and all well attended.

The number of new Resident Members	17
The resignations	14
The deceased	4

beside one Honorary and one Corresponding Member.

The Academy greatly needs re-inforcement by an increase of its Membership.

O. P. HUBBARD,
Recording Secretary."

The LIBRARIAN reported "the number of publications constituting our Library, at the end of the last year, aggregate to about 6500 volumes and 2000 pamphlets; and the addition received up to Nov. 27, 1882, to 205 volumes and 25 pamphlets. Since that date, 20 volumes, 135 parts and 197 pamphlets, reports, etc., have been received, amounting to a total accession, during the fiscal year of 1882, of 225 volumes and 357 pamphlets; which makes a grand total of 6725 volumes and 2357 pamphlets in our Library at the present time, exclusive of the publications presented this evening.

During the past year 211 volumes have been bound, leaving about 500 unbound volumes now on our shelves. The large number of periodical publications continually received, makes an arrangement for binding a continual necessity, to prevent our again falling behindhand, as we have done during many former years.

L. ELSBERG,
Librarian."

The Chairman of the Publication Committee presented the following report:

"During the year ending February 26th, 1883, there have been published three numbers of the Society's ANNALS, Nos. 9, 10 and 11, of Volume II. There remains still another part, No. 12, belonging to the

regular issue for 1882, and with which the second volume would close, which is not yet published and is still due to subscribers for that year. This part, it is hoped soon to issue.

Besides these, there were also published during the year covered by this report, although belonging to the issue for 1881, Nos. 7 and 8 of Vol. II.

The Academy is indebted to Dr. LAURENCE JOHNSON for Plate XVIII.,—the original map illustrating his article,—the entire cost of which was borne by himself; also, to Mr. Thomas Bland, Dr. Newberry, Mr. F. G. Wiechmann, and Prof. Thurston, for aid in the cost of illustrating with plates or cuts.

During the coming year, it will be necessary for the Academy to provide the additional amount needed for publishing the Index to the second volume.

The issue of the Transactions, which was begun in the fall of 1881, and referred to in the Committee's report, one year ago, has been carried on successfully during the year. Eight numbers,—one for each month of the Academy's session,—have been issued; and the second volume has been begun, for the session of 1882–3; although it is matter for regret that the means have not been provided to secure that promptness of publication so desirable, and so much hoped for, in a journal of this kind.

D. S. MARTIN,
Chairman Publ. Com."

The following officers were elected for the ensuing year:

President, J. S. NEWBERRY.
Vice-Presidents, B. N. MARTIN and A. A. JULIEN.
Corresponding Secretary, A. R. LEEDS.
Recording Secretary, O. P. HUBBARD.
Treasurer, J. H. HINTON.
Librarian, L. ELSBERG.

Council.

D. S. MARTIN. W. P. TROWBRIDGE.
G. N. LAWRENCE. A. C. POST.
T. EGLESTON. L. ELSBERG.

Curators.

B. G. AMEND. C. F. COX.
B. B. CHAMBERLIN. H. L. FAIRCHILD.
N. L. BRITTON.

Finance Committee.

T. B. CODDINGTON. P. SCHUYLER. T. BLAND.

The PRESIDENT communicated to the Academy that a Committee of the Council had conferred with the Trustees of Columbia College, in reference to a room in their new building on East Forty-ninth street, in which to hold the meetings of the Academy, and that they had given permission to occupy a room for this purpose, free of rent. It was

Resolved, that the thanks of the Academy be presented to the Trustees of Columbia College for the permission they have given the Academy to hold its meetings in the College-buildings.

March 5, 1883.

REGULAR BUSINESS MEETING.

The President, Dr. J. S. NEWBERRY, in the Chair.

Fifteen persons present.

The following persons were elected Corresponding Members:

Prof. LUIGI BOMBICCI, University of Bologna, Italy.

Prof. ANTONIO D'ACHIARDI, University of Pisa, Italy.

Prof. G. GRATTAROLA, Inst. Superior, Florence, Italy.

Dr. A. WEISSBACH, Bergakademie, Freiberg, Saxony.

M. EMILE BERTRAND, 15 Rue du Tournon, Paris, France.

M. A. JANNETAZ, College Sorbonne, Paris, France.

Prof. F. PISANI, Paris, France.

The CHAIRMAN exhibited a fine specimen of gold, associated with black oxide of manganese, from near the surface of a vein of quartz, in Southwestern Colorado, and also crystals of topaz, locally denominated quartz, from Nevada.

Dr. T. EGLESTON stated, that in 1862, two topazes were brought in by the Pacific Railroad Survey, which, after careful examination, lead him to announce that tin would be found in the vicinity from which they came. In 1874, he saw at Salt Lake City several specimens which were supposed to be a curious distortion of quartz, from Southern Utah, which turned out to be topaz. The discovery of these crystals, with the same associations, and of exactly the same form, as in Xacatecas, in the vicinity of tin mines already worked, is extremely important, as it implies the presence of tin, associated with these crystals, within the borders of the United States.

In speaking of the crystallized gold specimens, exhibited by Dr.

NEWBERRY, he pointed out that the native gold of the specimens was contained in the cavities left by the decomposition of pyrites.

Mr. ARTHUR H. ELLIOTT read a paper, illustrated by the apparatus, on

AN IMPROVED METHOD FOR GAS-ANALYSIS.

(Published in the Annals, 1883).

DISCUSSION.

Mr. G. F. KUNZ stated that, in assisting Prof. Wurtz in a series of gas-analyses, they had found that the Orsat-apparatus required several days for each analysis. All joints of the apparatus were kept lubricated with glycerine.

Dr. T. EGLESTON remarked that the Orsat-apparatus, which resembled somewhat that of Mr. Elliott, possessed very great advantages in making commercial analyses of gas, in the quickness and convenience of its use. It was very portable, and he had carried it up a high ladder, to a vat, in a whitelead works, made there the analysis of a gas, and brought it down to the ground again without any difficulty. It was, however, expensive, and was sometimes sluggish, especially in the determinations of carbonic oxide. It is, however, very suitable for the commercial analyses of gases. Mr. Elliott's apparatus is more suitable for the laboratory than for the works, because it is so very fragile. It is likely, also, to be sensitive to changes of temperature, which would necessitate making corrections for the variations of the volume of the gas, especially in very cold or very hot weather, when it might be necessary to have the apparatus jacketed, to allow sufficient time for the observations. How quickly the volume of gas will change by temperature, is shown in the oscillations which occur in the delicate air-thermometer, used in the Doyer apparatus. The special advantage, which is very apparent in Mr. Elliott's apparatus, is that the efficiency of the apparatus is always at a maximum, since the chemicals used are always new, and are arranged in such a way that they are exposed to a very large surface; for, while the surface is not as large as in the Orsat apparatus, in general, either in the tube or in the gauze part of the apparatus, it is amply sufficient with fresh chemicals for all practical purposes. While this apparatus does not have the same relation to commercial

work that the Orsat does, and is not so scientifically accurate as the Doyer, it must be regarded as a very great advance in laboratory work, both on account of its simplicity and its cheapness.

Mr. ELLIOTT stated his preference for vaseline for the lubrication of the joints of the apparatus. In regard to the absorption of carbonic oxide, he had compared analyses with those by the Bunsen method, and, in one instance, had obtained 27 per cent., by his apparatus, against 26.7 per cent., by that of Bunsen. He did not claim any greater accuracy for his apparatus, beyond the determination of constituents which amounted to tenths of a per cent. He had never observed any changes of volume, due to temperature, greater than a few tenths of a cubic centimeter in 15 or 20 minutes, while he and other persons were standing near the apparatus.

March 12, 1883.

SECTION OF CHEMISTRY.

The President, Dr. J. S. NEWBERRY, in the Chair.

Thirty-one persons present.

Prof. H. CARRINGTON BOLTON, of Trinity College, Hartford, Conn., read the second part of his paper

ON THE HISTORY OF CHEMICAL NOTATION.

(Abstract).

He had discussed on a previous occasion (December 11th) the early association of metals and planets, and the supposed origin of the signs used for both; he now took up the subject of alchemical symbolism, and traced also the later developments in chemical notation from the days of Geoffroy to Berzelius.

The indefatigable alchemists discovered new chemical substances more rapidly than they became acquainted with their proper relation to known bodies and to each other, so that the names assigned to them were arbitrarily chosen and frequently misleading. The love of the mystical also influenced alchemical terminology, very greatly obscuring it; in forming their vocabulary, the alchemists used the names of animals, plants, and of organic substances, as well as letters, numbers, signs of the zodiac, and an innumerable variety of arbitrary and conventional characters. To conceal their knowledge from the uninitiated,

they gave the same name to many unlike bodies, and used also a great number of synonyms. A highly metaphorical language arose, and when certain enthusiasts attempted to graft Egyptian mythology and Greek fables on to alchemy, the height of absurdity in nomenclature was attained. Nitre, for example, was called a "venomous worm," a "scorpion devouring his children," and a "dragon." The labors of Hercules, the Argonautic expedition, in search of the Golden Fleece, and similar legends received alchemical interpretations. The method of notation, which existed at this period, was no less astonishing; sal ammoniac, for example, being called an eagle, on account of its volatility, was represented pictorially as the bird of prey; antimony being denoted as a wolf, and gold as a king, the fusion of the two metals was represented by the picture of a wolf devouring a prostrate and crowned man. Allegorical formulæ of this character were especially cultivated by Dr. Michael Maier, physician to Rudolph II., and author of several illustrated works now much sought by bibliophiles.

As early as the thirteenth century, the four Aristotelian elements were represented as follows:

△ Air.

△ Fire.

▽ Earth.

▽ Water.

At some uncertain period, the elementary principles of alchemical theories were represented thus:

☿ Sulphur.

⊖ Salt.

♃ Mercury.

These are among the earliest of an enormous number of characters which the alchemists introduced into their writings. Many keys to these singular characters have been published; one of the earliest is that of Heinrich Eschenreuter, a reputed Bavarian priest of the fifteenth century; similar keys are found in the works of Crollius, Kircher, Juncker, Lefèvre, Lemery, Blancardus, *et al.*

The multiplicity of names in vogue among the alchemists gave rise to a large number of symbols, each synonyme having its appropriate character; thus mercury had at least 40 signs, borax 35, a crucible 18, cream-of-tartar 31, cinnabar 22, and so on. Dictionaries of these signs exist, the most noteworthy being that entitled the *Alchymis-*

tisches Oraculum, published at Ulm, in 1772, and a 400 page folio by J. C. Sommerhoff, published in 1701.

The speaker said he had carefully studied the abundant material afforded by these and other lists, and had sought some method of classifying these signs. He proposed the following scheme of classification:

I. Abbreviations.

MB Balneum mariæ.
Spiritus vini rectificatus.
Amalgama.
CC Cucurbita.
Σ Sucrum.
A river.

II. Pictorial Signs.

Feather alum (halotrichite.)
Water.
or sand.
Retort.
Crucible.

tin, iron, mercury and copper, and probably the signs for lead.

III. Symbolical Signs.

Hour.
Crucible (crux) or
Lime (calx, a spur).
Gold (sol).
Silver (luna).
Metallic regulus.
Oil (three drops ?)

IV. Arbitrary Signs.

Vinegar.
Cream of Tartar.
Common Salt or
Water.
Realgar.
Burnt Alum.
Iron.

and a very large number of numerals, for example:

4 Crucible.
25 Rock Salt.
80 Realgar.
33 Cinnabar.
18 Common Salt.
63 Cream of Tartar.

V. Complex Signs, formed by uniting two or more of the preceding groups.

Reverbertory Fire.
Aqua Fortris.
Aqua Regia.
Tartar Emetic.
Gold Leaf.
Silver Leaf.
B Balneum Arenæ.
Aqua Regia.
Aes Ustum.
Vinum Emeticum.
Antimonii Regulus.

By far the larger number of signs fall under Group IV, Arbitrary, but it is highly probable that many in this class are in reality distortions of signs belonging to one of the other groups.

The first intelligent use of these signs seems to have been made by the distinguished French chemist, Geoffroy, in 1718. He was the first to prepare tables showing the relative chemical affinity of substances; and he arranged the existing signs in columns to indicate their mutual relations. He added little to the notation, but discovered a new power in the symbols. The next step in advance was made by Torbern Bergman, who proposed to denote analogous bodies by similar signs having minor distinctions. His fundamental or basic characters were a triangle, a circle, a crown and a cross, and these he modified and combined in various ways to represent a great number of substances. Bergmann, however, carried out his excellent proposition very imperfectly. In Bergmann's Dissertation on Elective Affinities, we find the earliest style of chemical equations.

The speaker then referred to Lavoisier's scheme of notation, to the elaborate plan of Hassenfratz and Adet, and to the improvements introduced by Dalton, who revived the atomic philosophy and clothed it with new significance. None of these schemes were, however, destined to survive.

In 1814, the eminent Swedish chemist, Berzelius, published a memoir on nitrous acid, in which he discusses the different degrees of oxidation which nitrogen undergoes; in a modest foot note, he incidentally mentions that he frequently employs, in private memoranda, a convenient system of abbreviations for representing chemical bodies. This was the germ of the present rational system of notation, which has done so much to advance chemical science and to lighten the labors of students of every nationality. The Berzelian notation was not the result of any premeditated plan, carefully elaborated and presented to a Scientific Academy for their endorsement, but a simple device of a master mind, seeking to embody theoretical views in a practical manner. Twelve years later, Berzelius published a brief paper "On a method of expressing in formulæ the Composition of Bodies, as respects both their elements and the number of their atoms."

In this he describes the system, which, with slight modifications, now prevails wherever chemical science is known.

He proposes to denote each element by the initial letter or letters of its Latin name, and that such symbol shall represent the relative weight of one atom of the body designated. Berzelius remarks in this connection that the French mineralogist, Beudant, had the national vanity to employ the initial letters of French names, and suggests the desirability of employing Latin names, in consequence of the obvious

inconvenience attending the use of English, German and Italian names. He then quotes Sir H. Davy's remark, "Science, like that Nature to which it belongs, is neither limited by time nor space; it belongs to the world and is of no country and of no age."

Berzelius gives a list of the then known elementary bodies—forty-nine in number—and explains the use of co-efficients, both small and large, of barred letters for double atoms and of dotted letters for oxides. He employs the plus sign with very nearly the same significance as that of the period used at present. In all essential points, the existing system is identical with that introduced nearly seventy years ago.

With the rapid growth of the science, the Berzelian notation was found insufficient to express fully the mutual relations of constituent atoms, and constitutional formulæ were devised; these displayed formulæ gradually developed under the influence of the theory of atomicity into graphic formulæ, and, for educational uses, into glyptic formulæ.

The multiplication of the compounds of carbon, and the necessity of presenting accurate views of the differences in the constitution of isomeric bodies have led to the construction of prismatic formulæ, the development of which is still in progress.

The subject was further discussed by Prof. LEEDS, the PRESIDENT and the author.

March 19, 1883.

LECTURE EVENING.

No meeting was held, on account of the unavoidable detention of the lecturer in a Western city, by sickness in his family.

March 26, 1883.

The President, Dr. J. S. NEWBERRY, in the Chair.

Seventy persons present.

A private communication was presented, from PROF. WILLIAM B. DWIGHT, of Vassar College, Poughkeepsie, N. Y.:

"In some zoological explorations which I was making at Martha's Vineyard last summer, I was so fortunate as to find, what I never found before, a nest of newly hatched larvæ of *Limulus polyphemus*. As they are objects of much interest to zoologists, on account of their forming a

connecting link with the ancient trilobite, and as few succeed in getting hold of any, I think it very likely that some of them might be desired, and shall be most happy to donate some of my specimens. They are 4 mm. or less in length, and without the abdominal spine....Staining improves them very much and brings out a curious oval spot on the head-shield, external and somewhat anterior to the compound eyes; but it is somewhat difficult to get the color to strike in. Moreover, the saline matter retained within the outer crust makes some trouble with the coloring. The latter cause is now partially removed, as I have several times changed the alcohol, and is probably quite removable by longer soaking and changing."

The CHAIRMAN remarked on the interesting relationship of the "horseshoe crab" (*Limulus*), and the ancient trilobite, and the difficulty of obtaining the larvæ, in spite of the abundance with which they somewhere breed.

About 200 specimens of the larvæ were distributed, later in the evening, among the members of the Academy present.

Prof. CHARLES B. WARRING, of Poughkeepsie, N. Y., then read a paper, entitled:

A STUDY OF THE CHALDEAN "ACCOUNT OF CREATION,"

as translated by Mr. George Smith and Profs. Sayce and Lenormant, and also of the account of Berosus, in reference to their connection with the first chapter of Genesis.

(Abstract).

There are three kinds of Chaldean myths; those purely mythological; those referring to the Deluge; and those said to give an account of the Creation,* and, which, it is claimed, are the originals of the story, in the first chapter of Genesis. Of these "creation" myths there are three: that on a series of tablets—the most famous one, that found on the tablet of Cutha, and the story related by Berosus.

The object of the present paper is to examine this claim, first, by inquiring whether there is historical evidence in its favor. There appears to be none. Secondly, are there strong probabilities in its favor, which themselves rest on admitted facts? Only two have been named, the great age of these myths, and the fact that the Hebrews were carried to Babylon and remained there many years. However it may be as to the other myths, all admit that the "creation" myth was written in the reign of Assur-bani-pul, 670 B. C., no very great age as

"*No Chaldean account of the Fall has as yet been found." Prof. Sayce's Smith's Chaldean Genesis, page 88.

compared with the epoch of Ezra, and many centuries after the time of Moses.

As to the Hebrews being in Babylon, it is an historical fact that those who returned to Judea did so with the most intense hatred of every form of idolatry; it is therefore incredible that they adopted the religious myths of hated and despised idolators and embodied them in their own sacred books, even giving them the place of honor.

As some will say, "however strange it may appear, nevertheless the Hebrews did take the heathen myths and adopt them, for here they are." This can be met only by a careful examination of the myths and of the Creative account in Genesis. If the two are identical in their teachings, then we may conclude that one was the source of the other. But if their agreements are few and of little importance, if, *e.g.*, both speak of earth and heavens, of plants and animals, such agreement would be of little value, because by no possibility could a cosmogony be written and not speak of these. If at the same time their disagreements are many and important, if in fact their statements are radically opposite, then it is impossible that the one should have been derived from the other. The paper then went into an extended comparison of the myths with the story in Genesis. The myths were given in full, and their few resemblances to the Hebrew account, together with their many flat contradictions were pointed out. For example, the myths place the heavens and earth before the gods. Genesis says, God was first. The whole first tablet is occupied with the origin of the gods. The "beginning," it says, was that point in the existence of the heavens and earth when the great gods began to be. In Genesis, the beginning is that point in the existence of God at which the heavens and earth began to be.

In the fifth tablet (all the others are missing, except possibly one little fragment which says only this: "The foundation of the caverns of rock thou didst form"), which is claimed to correspond to the fourth period in Genesis, it is said that one of the gods *arranged* the stars in three rows of constellations. Genesis says God *made* the stars. The myth says that the god made a stair-case in the midst of the earth. Nothing like this is found in Genesis. The myth gives great prominence to the stars, Genesis says little of them. The myth makes the month, and the moon in connection with its office as a measurer of months, by far the most prominent things in it. Genesis says absolutely nothing about months—does not mention them.

There is one more fragment. In this it is said that the gods made "cattle of the field, and beasts of the field, and creeping things." This is the only real resemblance to Genesis, and this could not well be avoided if both were to speak of animals.

The tablet of Cutha is so grotesquely absurd, that no one claims that it, or any part of it, is embodied in the Hebrew account. The same is true even in a stronger degree of the story related by Berosus.

The myths have no division into creative days. They have no fiats. The gods do not pronounce their work good. The Hebrew account is divided by the creative day verses into six periods. Every creative act is preceded by a fiat, and six times God pronounces His work good, and then He sees all that He has made and pronounces it very good.

There is nothing like this in the myths. It is therefore absurd to say that these were the sources from which was taken the account in our Bibles. In conclusion, it was stated that these myths are not a cosmogony at all, or, at least, this is not their primary purpose. They form a theogony. They set forth the origin and descent of the gods, and join to each his supposed share in arranging the world and the heavens. As such they are intelligible and duly proportioned.

DISCUSSION.

Dr. B. N. Martin remarked on the interest of the comparisons which had been made, and assented to the conclusion, in regard to the scanty similarity of the two accounts. In the many gods worshipped by the Greeks, Egyptians, and Chaldeans, there was nothing ultimate, and the question always presented itself—whence these gods came. In the Hebrew account, however, the Supreme Agent was self-existent and self-dependent. Also, in modern philosophy, there is a continual tendency to the resolution of all the varied physical forces into a single, infinite, always existing Force—the "Force of the Infinite" of Herbert Spencer. It was an important distinction, made by the author of the paper, that all the other ancient philosophies were theogonies, while that of the Hebrews was a cosmogony, one produced by a personal Infinite Force.

Rev. H. C. Hovey observed that from a purely historical and rational point of view, although, on the one hand, the Hebrews had been closely associated with the Chaldeans, through their Chaldean progenitor Abraham, and in the early intercourse of his sons and grand-sons with that people—on the other hand, a long break of four centuries took place in that intercourse, while the Israelites were in Egypt; so that Moses was far more likely to have been influenced from Egypt than from Chaldea, in writing his cosmogony.

The CHAIRMAN considered the facts yet too few and imperfect to establish any fair criticism.

There was, however, another Chaldean account, that of the Deluge, which was very interesting and clear—so close to the Biblical account, indeed, that there must be some connection between them. The tablets under discussion were comparatively modern, reaching back not over 800 years B. C.; there was, therefore, no proof that the undoubtedly far more ancient Biblical account had been derived from these. He called attention to the recent discoveries by Mr. Rassam of ancient records, at Aboo Habba, in the valley of the Euphrates, in one place, of nearly 40,000 tablets, which, although composed of soft clay, had been nearly all preserved intact by the discoverer, by a method of careful baking. So, too, in the ruins of the so-called Tower of Babel, masonry, timbers, etc., had been recently found in such a state of preservation as to render probable the discovery soon of records of some kind at that locality.

At present there was too great an imperfection in the records, and also too little acquaintance with the languages of those records, as had been illustrated by the discrepancies of the several translations presented in this paper, to justify positive statements.

Nevertheless, it was a remarkable fact that, for the last two or three thousand years, a detailed record of the Creation has stood before the world. In the progress of geological discovery, astonishing correspondences have been established, in reference to this Biblical record, incomprehensible unless derived from a supernatural Power.

April 2, 1883.

SECTION OF GEOLOGY.

The President, Dr. J. S. NEWBERRY, in the Chair.

Thirty-four persons present.

A paper was read by Dr. J. S. NEWBERRY, on

AN INQUIRY INTO THE ORIGIN OF THE CARBON PRESENT IN BITUMINOUS SHALES.

(Published in the Annals.)

DISCUSSION.

A MEMBER assented to the general view maintained in the paper but inquired whether it was intended to draw any analogy between the

vegetation from which the carbon in the shales was derived, and the aggregations of gulf-weed in the "Sargasso Sea," etc. It was entirely improbable that, however dense the vegetation might be upon the surface of the ocean in such regions, any accumulation of carbonaceous matter could take place upon the oceanic bottom, from the exceedingly slow rate at which mineral detritus can be there deposited to protect such organic matter from oxidation ; nor have any such accumulations been found in the deep-sea dredgings of the *Challenger* or other expeditions.

Dr. NEWBERRY doubted whether any dredgings had ever been made beneath the Sargasso Sea, but he also disbelieved in the possibility of such a carbonaceous deposit in the deep ocean. He had only desired, by the allusion to the Sargasso Sea, to indicate the probability of a similar aggregation of floating algæ upon the surface of the shallow waters beneath which these shales must have been formed.

April 9, 1883.

SECTION OF CHEMISTRY.

The President, Dr. J. S. NEWBERRY, in the Chair.

Thirty-five persons present.

The CORRESPONDING SECRETARY called attention to the recent death of Dr. JOSEPH PRIESTLEY, of Northumberland, Penn., the last surviving descendant of the eminent chemist of that name, and remarked on his genial kindness and eminent talent as a physician, and the influence of his character and position, by which he generously assisted in the success of the Centennial Celebration of American Chemists at Northumberland, in the summer of 1874. After discussion by Mr. ELLIOTT and the President, it was

Resolved, that the Corresponding Secretary be requested to convey to the family of the deceased our sincere sympathy in their bereavement, and our high appreciation of his character.

Dr. ALBERT R. LEEDS then read a paper, entitled:

AN ACTINIC METHOD FOR THE DETERMINATION OF ORGANIC MATTER IN POTABLE WATER,

with the application of the method to the water supplies of Philadelphia, Newark, Jersey City, Brooklyn, and New York.

At the present time there is no method known of determining accurately the amounts and kinds of organic matter existing in the water we drink. The amounts are so small, the kinds so various, the in-

stability of much of the organic matter so great, that the best we can do is to make a tolerably accurate estimation of the total amount, and endeavor to find out what portion of this is safe and what is possibly dangerous to health. To make this scientific guess, so to speak, various expedients have been hit upon, and a vast deal of thought, controversy and time have been expended. The mode most in vogue is to heat the drinking-water with an alkali and a powerful oxidizing agent, and to find how much ammonia distils off from it. The ammonia thus obtained is regarded as a measure of the putrefiable organic matter present. Another way is to find out just how much nitrogen and how much carbon are present, and, from the fact that animal substances have a much higher proportion of nitrogen to carbon than vegetable substances, to conclude whether any dangerous bodies of animal origin are present. These two ways are greatly in use in England. The Germans place great confidence in a third method, which is to find how much of the organic matter is capable of being oxidized by permanganate of potash when the water is being boiled with this strong oxidizer, and to regard this oxidizable fraction of the organic matter as the part dangerous to health, and of importance therefore to consider. In France, again, much stress is laid upon finding out how large an amount of oxygen is dissolved in the water, on the ground that if there is much less present than is always found in really pure water, there is reason for believing that the deficiency is due to the absorption of oxygen by bodies undergoing decay and putrefaction.

The new method, I am about to propose, depends upon the fact that compounds of silver are not decomposed by light, when they are in solution in water, unless organic matter is present in the water also. If sufficient care is taken to exclude every trace of organic matter, even such as might accidentally enter from the dust of a room, silver solutions may be kept in the sunlight for years without change. Another fact lying at the foundation of this new process is, that stable organic bodies, like sugar, starch, gum, etc., have very little influence, while decomposing substances, like excreta of all kinds, throw down the silver very rapidly.

[Here a bottle was shown in which some sewage-water had been added to a solution of nitrate of silver, and then exposed to sunlight. The whole interior of the bottle was covered with a bright mirror of metallic silver. Another bottle was shown containing some Croton water drawn at the Christopher St. Ferry last Saturday. It was covered at the bottom with a black deposit of metallic silver, nearly but not quite so great in amount as a similar sample taken from the Passaic River (the water-supply of Newark and Jersey City) a week before.]

The amount of silver thus thrown down can be readily weighed, and the relative amounts of organic matter present in the water thus determined. A sample of Brooklyn water, taken Mar. 4th, when the water had deteriorated, showed this fact by the large amount of silver which it precipitated. And during the month of January, when I was called on to Philadelphia to examine their water-supply, at that time very offensive to both smell and taste, this method of examination was extensively used. It showed, among other things, that when sufficient air was passed through the Philadelphia water to raise the percentage of oxygen to the proper amount, the decomposable organic matter was largely destroyed; and samples thus treated threw down just so much less silver, on exposure to sunlight, as there had been organic matter destroyed by previous oxidation in contact with air. This elucidated the origin of the difficulty with the Philadelphia water. It had not been aerated sufficiently to get rid of the decomposable organic matter which it contained, and which communicated its offensive taste and smell.

DISCUSSION.

Mr. A. H. Elliott remarked, in reference to the determination of free ammonia in water by distillation with sodium-carbonate, that albuminoids are decomposed in this way, and that the method is fallacious: since, for example, in the case of urea, ammonia is given off before potassium-permanganate and caustic potassa are added.

The potassium-permanganate is itself full of ammonia, unless it has been previously purified.

The methods of Wanklyn and Frankland were brought up in violent controversy at the meetings of the Chemical Society of London. Frankland's method was found to be too cumbrous, and there was nothing to be gained by it, since, like Wanklyn's, it only afforded an index of the organic matter present. The distinction between free and albuminoid ammonia was of little value.

The connection of the healthfulness of waters with their content of organic matter was but vaguely established, since, for example, that of the Dismal Swamp was dark-colored and teeming with organic matter, and yet was not proved unhealthful. Prof. Huxley could see only one use in the determination of the organic matter, with reference to it as a basis for the development of germs. Prof. Koch had proposed a method of the development of bacteria in gelatine-films, which had not yet apparently been sufficiently tested.

He farther inquired whether the solution of tartaric acid, and that of milk-sugar with silver nitrate, were not affected by light.

Dr. Schoeney described the precautions to be observed in Koch's method, and inquired whether the living germs in a water became recorded by the same results—envelopment in a cloudy vesicle—as the merely decomposable organic matter.

Prof. Leeds replied that he had applied his method to a series of polluted drinking waters and many organic substances.

He had applied Koch's method, according to the plan recently suggested by Dr. Angus Smith, to the Philadelphia water, in tall jars, compared with others containing sewage and a hay-infusion. But, strange to say, no action occurred even in the two latter after five days, only a slight turbidity appearing upon the surface of the hay-infusion. Eventually the liquefaction and turbidity of the gelatine took place in all and the results fell to the bottom, only microcci and bacteria, not bacilli, being detected in the liquid.

The products of decomposition of the gelatine, that which had been transformed and stinking under the action of the microcci and bacteria, and in which these organisms were now dead, affected the silver salts powerfully; the gelatine, which had not been transformed, but was in its original condition, exerted little influence upon the silver salts in the presence of light.

April 16, 1883.

Lecture Evening.

The President, Dr. J. S. Newberry, in the Chair.

The large hall was filled by an interested audience, who listened to a lecture, illustrated with diagrams and lantern-slides, by Prof. Hamilton L. Smith of Hobart College, Geneva, N. Y., on

THE GREAT PYRAMID, AND THEORIES CONCERNING IT.

(Abstract).

After a short sketch of the geographical position of the pyramids of Lower Egypt, illustrated by charts and maps, and a notice of their difference in structure, considered as tombs, from all the other tombs in the neighborhood, and a somewhat extended study of the monu-

ments of the fourth dynasty, followed by a minute account of the Great Pyramid, and its peculiarities, and a notice of some of the fanciful theories with regard to it, the lecturer proceeded to show that the hitherto neglected difference of angle, between the descending and ascending entrance passage of the Great Pyramid, was really the key to the explanation of the otherwise unexplained fact, that all the pyramids have the entrance passage on the northern side, and approximately pointing toward the pole of the heavens. That these passages were intended, or rather that of the Great Pyramid, for some reason, to point as near as might be to the then polar star (Alpha Draconis) had already been generally admitted, but, in attempting to make this a basis for chronology, there is an uncertainty of some 1300 years in the case of the Great Pyramid, which has the entrance passage pointing about 3° 42′ from the true pole. Twice in the processional movement of the stars, Alpha Draconis has been at this distance, once 3400 years B. C. and again 2160 years B. C. The former era is adopted by Mr. Proctor in his recent book; the latter, or near this, by Prof. Piazzi Smyth. Neither of these authors seems to have considered that the difference of angle between descending and ascending passages was of any particular significance. Mr Proctor supposes that observations were made down the ascending passage, by reflection, for purposes of orientation. Some five years ago, the lecturer had suggested this use, not for purposes of orientation, but as indicating, by the change of angle of elevation of the pole star, the interval elapsed between the date of the commencement of the pyramid, and the time of arriving at the altitude of the king's chamber, and this difference, 9 minutes of arc, corresponded to twenty-five years. Moreover, the angle of the ascending passage being the smaller, indicated that Alpha Draconis had already made its nearest approach to the pole, and was now receding, thus deciding for the later of the two periods, *i. e.*, 2160, or thereabouts, for the date of erection of this pyramid.

The lecturer proceeded to apply this hypothesis to the other pyramids. The so-called third pyramid on the Jeezeh hill, that of Mycerenus, is acknowledged by all to be later than the Great Pyramid, and the angle of the descending passage of this pyramid, as given by Vyse and Perring, when compared with the angle of that of the Great Pyramid, as measured by Prof. Smyth, indicates that it was built some 80 years later.

The angles of the entrance passages of most of the pyramids have been very loosely measured, but taking them as they are, and applying the same hypothesis, the lecturer obtained the following results:

1. Great Northern of Dashoor, about ..... 2410 B. C.
2. Northern of Abouseer, about ..... 2260 B. C.
3. The "Second" of the Jeezeh group, ... 2170 B. C.

4. The "Great" of the Jeezeh group, at elevation of Kgs. ch. 2136 B. C
5. The Southern of Dashoor. .....2113 B. C.
6. The Pyramid of Mycerenus, 3d Jeezeh.....2090 B. C.
7. The Stepped Pyramid, Sakkarah.....2010 B. C.

The last named had already been attributed by ablest Egyptologists, to the 5th dynasty; and in regard to the third in the list, it had already been assigned to Cheops by Bunsen, and the fourth, the "Great," to his successor Shafre, or Cephren, this being the hieroglyphic name of the pyramid of this monarch. It would seem, then, that the so-called "first" or "Great Pyramid" on the Jeezeh hill, was really the second, and it hardly seems probable, if it really was the first, that it would have been nearly pushed off the hill, when the whole situation was yet clear. The chalk marks, names of Shofo (Cheops) and Nu-Shofo, on some of the stones of the Great Pyramid, in places where it was never intended they should be seen, are of no value as determining that either of these kings built the pyramid; they were merely scribblings of the workmen. The lecturer showed that the builders of the pyramids had tube-drills and saws, charged probably with beryls, for cutting basalt, syenyte and dioryte; and that the testimony of the monuments, as interpreted by Mariette, Maspero, Brugsch and other scholars, contradicted the statements of Herodotus and proved that, so far from being a degraded people, tyrannized over by despotic monarchs, they were a highly intelligent and happy people, well governed, and with a comparatively pure and simple religious belief.

At the conclusion of the lecture, Dr. B. N. Martin moved a vote of thanks to the lecturer, which was carried unanimously.

April 23, 1883.

Lecture Evening.

The President, Dr. J. S. Newberry, in the Chair.

The large hall was filled by an audience to listen to the lecture of Chevalier Ernst von Hesse-Wartegg, postponed from March 19, on the subject of

SOUTHERN EGYPT AND THE COUNTRIES OF THE FALSE PROPHET.

The lecture was illustrated by a large map and many photographs, and at its close a vote of thanks was passed to Chevalier von Hesse-Wartegg for his instructive and pleasantly delivered lecture.

April 30, 1883.

SECTION OF GEOLOGY.

The President, Dr. J. S. NEWBERRY, in the Chair.

Forty persons present.

Mr. G. F. KUNZ exhibited a fragment of the meteoric stone which fell at Alfianello, Lombardy, on Feb. 16, 1883, at 3.30 P. M.; also cut specimens of Siberian amethyst of wonderful color and brilliancy, and Siberian aquamarine, the finest gems of these kinds he had ever seen. He also stated that, in a large bag of pebbles of jasper, agate and chalcedony, from San Geronimo, Estado de Oaxaca, Mexico, near the Isthmus of Tehuantepec, he had found a worn pebble of blue and yellow corundum, weighing over nineteen grammes. The specific gravity is 3.9002, which is low, but probably caused by internal fissures, partly occupied by other material. It retains no trace of crystalline form, but the cleavage-planes reflect very plainly a pearly lustre. The discovery of this mineral in so good a form may imply its possible occurrence in quantity and perhaps with a gem value.

Mr. WILBUR exhibited, through Prof. D. S. MARTIN, a specimen of our finest and largest moth, *Saturnia* (*Samia*) *Cecropia*, which had been hatched out unusually early this spring, probably in in some sheltered spot.

The PRESIDENT stated that the meteorite, of which a fragment was exhibited, fell in a clover-field, and attracted such a crowd of visitors that the enraged proprietor of the field had it broken up and thrown out into the road. A portion of the fragments thence obtained was sold soon afterward for about 7000 lire (or francs), in which the proprietor of the field had no share.

A paper was then read by Mr. N. H. DARTON,

ON THE DISINTEGRATED SANDSTONE AT NEW DURHAM N. J.

(Abstract.)

In the construction of the road-bed for the New York, West Shore and Buffalo Railroad, numerous interesting exposures of the Trias in New Jersey have been revealed in its cuts, tunnels, etc. At several points the contacts of the trap and sandstone have been uncovered. One of the most remarkable of these is at the western entrance to the tunnel through the Palisades, between Weehawken and New Durham where the sandstone is very soft and friable, containing a large amount of water, and of nearly pure white or chromiferous green color. On

drying, it falls to a fine powder, most of which will pass through a sieve of sixty meshes to the inch. It is composed of a mixture of about equal parts of a porous earthy substance and of grains or crystals of quartz. These crystals are frequently two or three lines in length, quite pure and transparent, and of simple habit; often their edges are rounded and show signs of abrasion. Whether they contain fluid-cavities or not, has not been determined. In places a few pebbles and sharp fragments of trap occur, besides a fair representation of all the formations below it, especially of Potsdam sandstone; of granyte no fragments characteristic of any particular locality were found.

The strata thus conditioned lie against the trap, and have a thickness of about two hundred feet; overlying them is a hard, light colored granular sandstone. Their dip, and that of all the sandstone exposed here, is 20° to N. 50° W. The trap stands at an inclination of about 80°, and at its contact the sandstone shows no marked signs of fusion.

There are a few other localities in the State where the sandstone is similar to this, viz.: about four miles from Trenton, and at two points north of the locality at New Durham. In the reports of the State geological survey they have been termed "crumbling sandstones," and described as a mixture of quartz-grains and of a decomposing feldspar. Samples were collected at New Durham in such a manner as to fairly represent the formation from the contact with the trap, and between this and the trap, at several points. The trap was also analyzed, and the results are given in the last column of the following table. Analyses of characteristic unaltered sandstones, made some years ago by Dr. P. Schweitzer, are also given for comparison. The alkalies were determined by Dr. J. Lawrence Smith's method, and the remaining constituents by fusion with carbonate of soda. Iron was estimated volumetrically.

						Dr. Schweitzer.		
	No. 1	**No. 2**	**No. 3**	**No. 4**	**No. 5**	**No. 1**	**No. 2**	
	At Contact.	*30 Feet above No. 1.*	*60 Feet above No. 1*	*100 Feet above No. 1.*	*Top.*	*Newark Quarry.*	*Haverstraw.*	*Trap at Contact.*
SiO_2	70.01	74.41	73.24	75.18	79.10	80.53	77.70	51.73
Al_2O_3	22.92	18.23	15.34	18.01	14.08	9.92	11.81	16.14
Fe_2O_3	.76	1.03	2.10	1.42	.83	1.99	1.89	14.34
MgO	1.21	.91	1.78	.72	1.40	.63	.43	6.03
Mn_2O_3	.09	Nil.	Nil.	.06	Nil.	trace.	trace.	Nil.
CaO	.04	"	"	Nil.	.23	.63	.55	6.75
Na_2O	2.18	2.70	1.04	2.16	1.12	5.67	6.89	2.11
K_2O	Nil.	Nil.	.04	Nil.	.09	Nil.	Nil.	1.47
H_2O	.433	2.46	6.68	} 2.33	} 3.18	} 1.74	} .82	} 2.33
CO_2	.14	Nil.	Nil.					
SO_3	.03	.23	trace.	.07	Nil.	Nil.	Nil.	Nil.
CuO	Nil.	.01	Nil.	Nil.	trace.	"	"	"
Totals	101.71	99.98	100.22	99.95	100.03	100.51	100.09	100.40

SOLUBLE IN HYDROCHLORIC ACID.

SiO_2	.24	.71	.48	.21	.87	.30	.42
Al_2O_3	.16	.08	.74	.11	.40	.12	.36
Fe_2O_3	.74	1.06	2 04	1.48	.87	2.01	1.87
MgO	1.21	.90	1.82	.70	1.46	.31	.43
CaO	.03	----	----	----	.25	.33	.37
Na_2O	.17	.29	.06	.24	.14	.37	.02
SO_3, etc	.06	.34	.02	.10	.07	.00	Nil.
Soluble	2.61	3.38	5.16	2.84	4.06	3.44	3.47
Insoluble	92.92	94.16	88.16	94.83	92.76	95.42	95.71
Water and CO_2	4.47	2.46	6.68	2.33	3.18	1.14	.82
Totals	100.00	100.00	100.00	100.00	100.00	100.00	100.00

The analyses show a nearly uniform composition for the entire thickness, and the only marked difference from the unaltered sandstone is in the soda. Whether this is the remains of a triclinic feldspar or not, I do not feel confident to claim, as the granytic areas, forming the basin in which the Triassic beds of the Eastern States lie, and from which we have supposed them to be derived, are not albitic in character, except in some very local instances. However, in a formation of this character, the content of soda is generally attributed to albite, of which, from the analysis, it would seem that there is from fifteen to twenty per cent. present in the disintegrated sandstone, and about fifty per cent. in the unaltered. These are very appreciable proportions and quite constant throughout the Triassic stratum. By our latest calculations the thickness of this seems to reach at least twenty-five thousand feet, on the western side of the uplifted granytic area, which separates the Triassic deposits represented in New England and in the South Central States.

DISCUSSION.

The PRESIDENT stated that the rock in question was called arkose, but often so rich in feldspar as to be a true feldspathic sandstone.

A MEMBER remarked that an outcrop of the same rock, in entirely unaltered condition, occurred all along the eastern foot of the Palisade range, from Jersey City to Weehawken. The absence of albite might possibly have been derived from the degradation of some albitic granyte on the shore of the Triassic sea, though he was not aware of the occurrence of such a rock in the Laurentian of Northern New Jersey; more probably it had been caused by the entire decomposition of the ferruginous orthoclase in the granyte derived from that region, with the corresponding concentration of the associated soda-feldspars.

Mr. DARTON referred to the existence of albitic granytes near the borders of the Triassic basin in Virginia, etc.

Prof. D. S. MARTIN observed that on the east side of the Palisade range, back of Hoboken, an exceedingly beautiful arkose was formerly seen at a locality, since largely destroyed, known as Fox Hill, but the feldspar in it was to all appearance orthoclase. In the rocks of New York island, the orthoclase has sometimes passed completely into kaolin, leaving the other feldspars unchanged. It is possible that a stratum of these rocks may once have formed the eastern shore of the Triassic basin, and their debris must have been rich in orthoclase. He had long ago adopted the view, since fully detailed in a paper by Mr. I. C. Russell, in our Annals, of the former union of the two Triassic sheets of New Jersey and the Connecticut valley, afterward separated by the elevation of the central ridge passing at present through New York island. A part of the Triassic deposits in our vicinity may have been then derived from the old eastern border of the original basin, in Connecticut, where albitic granytes occur.

The PRESIDENT referred to the confusion which had once existed in the views entertained regarding the sandstones and traps, the latter having been considered by some merely as the results of a metamorphic action along certain layers of the Triassic sediments. At that time he had initiated an investigation, which had been carried on to a satisfactory result by Dr. P. SCHWEITZER, demonstrating the complete difference of the sandstone and trap, and the true intrusive character of the latter.

A paper was then read by Dr. ALEXIS A. JULIEN,

ON THE DECAY OF BUILDING STONE, PART II,

with illustrations from the old cemeteries of New Utrecht, Flatbush, etc.

(Abstract).

The present and increasing magnitude of building operations in this city and vicinity must serve as an apology for bringing the subject of the decay of stone a second time before the Academy this season. The various suburbs and vacant districts have been gradually approaching a character sufficiently settled to justify the erection of entire and numerous blocks of private residences, huge buildings for business offices in the lower part of the city and for family flats in the central and upper wards, besides large numbers of public edifices, storage houses, manufactories, etc. The failure of stone to resist fire in the business district, and the offensive results of discoloration or serious

exfoliation, which the poor durability of many varieties of stone has rendered manifest in all parts of the city, have already largely diminished its proportionate use, in reference to brick. Nevertheless great quantities of stone of many kinds are yet introduced, as ashlar or the trimmings of apertures, into the buildings now in progress, and will soon be further employed, if the present activity in building be continued, not only in the private enterprises already mentioned, but others of more lasting and public importance; *e.g.*, the projected improvements and additions in connection with our water supply, as aqueducts and reservoirs; the new bridges proposed over our rivers; the replacement of our rotting wooden docks by more permanent structures; and perhaps, we may hope, the huge pedestal to support the Statue of Liberty on an island in our harbor. As the kinds of building-stone brought to this market for these purposes are increasing in number and variety, and their selection and mode of use, as it seems to me, are irregular and indiscriminate, whether from the ignorance or the carelessness likely to prevail in a busy money-getting community, it would appear proper that a voice of warning should now be heard, from a member of the Academy of Sciences, calling attention to the dangers involved in the use of bad stone or the bad use of good stone; in the enormous waste and expense soon required for repairs in our severe climate; or, in the consequent disuse of stone in favor of brick, by a natural reaction, to the injury of the beauty and comfort of our city.

There are three classes in the community to which such a warning is addressed:

1. A considerable number of house-owners, to whom it seems to come too late, since they have already expended tens of thousands of dollars in temporary repairs, patching and painting decayed stone, and many of whom have doubtless made rash vows to use hereafter, in construction, brick, iron, terracotta, wood—anything but stone.

2. House-owners, not yet aware of the coming dilapidation, and who can yet take precautions to delay or prevent its arrival—or others about to build, and who have implicit faith in the eternity of building-stone, since it comes from the "everlasting rock," or at least in a duration which will last their lifetimes—and, also a certain proportion of builders and architects willing to learn, and who have much to learn, since the practical scientific study of building-stones is yet to be made.

3. And lastly, the architects, builders and contractors, who know all about the subject, or who do not care what happens to the houses they build—and that large part of our population who never expect to own any houses. To all these the decay of the stone in this city is a matter of indifference, and the quotation recently presented

from an encyclopedia of architecture, "no modern building will stand a thousand years"—few of them, indeed, over a century or two, in fair condition—is only a matter of jest.

The following additional facts, observed in reference to the decay of stone in this city, have been gathered partly by observation in our streets, and partly by a study of the tomb-stones in the old cemeteries at New Utrecht and Flatbush, on the southern and northeastern outskirts of the city of Brooklyn, L. I., and in that of St. Paul's Church, at the corner of Broadway and Fulton street, in this city. In my last paper I presented observations on the stones in the churchyard of Trinity Church, built in 1846 (the first building having been erected on that site in 1696). St. Paul's Chapel was erected 1766, and, although this structure is older than that of Trinity, its cemetery is much more recent in its origin.

BROWN SANDSTONE.

In addition to the varieties already described, there is one quite recently introduced into this city from Hammelstown, Penn., in a building on Fifth avenue above 41st street. It has been largely used in Philadelphia, and is said to resist the weather very well.

The causes of the general decay of brown-stone may be definitely connected with some of the agencies which were detailed in my former paper.

Erection on edge of lamination.—Instances are very rare in this city where the stone has been laid "on its bed," with a deliberate regard to its durability: *e. g.*, a few houses on Fifth avenue above 51st street, the new wings of the Astor library, etc. On the other hand, from mere convenience in construction, many buildings, especially of our older churches, are fortunately so constructed, the blocks having been small and square and conveniently so laid. In some instances, (*e. g.*, the church on the southeast corner of 35th street and Fifth avenue), blocks occur in both positions and in both are affected by incipient decay; in others (*e. g.*, the church on southwest corner of 21st street and Fifth avenue), the blocks, although all on bed, are often deeply decayed. In the old City Hall, erected in 1812, the north face, although on the side usually least affected by decay, presents the brownstone of its ashlar set on edge and exfoliating in entire sheets, often traversed by fissures across the lamination, parallel to the joints. Notwithstanding these warnings, most of our newest edifices exhibit the same faulty construction: *e. g.*, the sandstone (from Massachusetts) n the trimmings and even partly in the pillars of the Union League Club on Fifth avenue, the fine new residences in the upper part of Madison avenue, the trimmings, etc., in the huge new buildings for "flats" and business offices throughout the city, often nine to eleven

or more stories in height, in whose walls the crushing force exerted upon this soft stone must be excessive.

Sea-salt in the atmosphere.—A comparison of the forms of decay of stone observed in the cemeteries within this city and in those nearer the ocean, *e.g.*, at New Utrecht, yielded no evidence of any results, attributable to this agency, in greater action at the latter locality. Thus, too, in England, the sandstone of Sandysfoot Castle, near Weymouth, which has been washed by salt spray since the time of Henry VIII., remains as perfect as ever.

Heat of the sun.—There can be no doubt that this is one of the agencies which most severely attack our brown-stone. On the cross streets, the west sides of stoops become decayed and ragged, long before the eastern; so also the southern before the northern sides, on our north and south avenues. The ashlar at the base of the steeple of the church at 37th street and Fifth avenue is beginning to decay on the south side, but not on the north or east sides (the west side not being visible). The slender balusters of the balustrades of balconies and along the sides of stoops are commonly constructed of soft sandstone, with the lamination vertical and its plane set irregularly, either parallel or at right angles to that of the house front; the ill-judged exposure of the soft stone in such a way has led to the common mutilation of the carved work by exfoliation on the side exposed to the sun, *i. e.*, on the west side of the stoop-balustrades in the cross streets, and on the south side along the avenues.

Lichens.—It has been stated that these abound upon the brown-stone within the city, but, though found upon trees, I have never discovered them encrusting hewn stone within the city. Thus they never occur in the churchyards of Trinity church and St. Paul's chapel, though found abundantly in those of New Utrecht and Flatbush; *e. g.*, three species were distinguished upon a single tombstone (Rutgert Denyse, 1795) at New Utrecht. On their removal, the surface of the stone beneath is not found corroded, but only retains a fresh color.

Imperfect pointing.—The admitted energetic agencies of decay—frost, solution, hydration, etc.—have been largely favored by the imperfect and hasty construction of the masonry throughout the city, its joints when new often admitting a trowel. A cement-mortar of poor quality is largely employed and, soon dropping out, the joints are often allowed to remain open for years. The atmospheric attack is thus made, as it were in flank, directly through the exposed edges of the outer laminæ of the stone, and the decay rapidly affects the stone to a considerable depth, several inches in many cases, and even throughout the entire block, although the exfoliation may appear superficial.

Cemetery at New Utrecht.—Two varieties of sandstone were found commonly employed here, the stones standing vertically and facing the east.

1. Fine-grained and compact, warm red to reddish brown in color, apparently derived from Little Falls, N. J. The stones dated from 1830 back to 1785, and are in excellent condition, especially in proportion to compactness and fineness of grain (*e.g.*, C. Van P., 1796).

2. Red, often fine-grained, and generally laminated, the laminæ being one-eighth to one-half inch in thickness, with alternations of reddish shades of color. The stones date from 1854 back to 1820, and have weathered very poorly, splitting first near the west face of the stone and finally throughout, often with fissures cutting the stone across the lamination and parallel to the edges (*e. g.*, W. B., 1826).

A light gray graywacke also occurs (S. B., 1852), but is thinly laminated and split in fine cracks throughout.

Cemetery at Flatbush.—The same varieties are here employed and the stones stand in the same position. Those of the compact variety date from 1800 back to 1754, and are in excellent condition (*e. g.*, Marrytie D., 1797.) Tnose of the laminated structure date from 1826 back to 1754 and are generally in wretched condition (*e. g.*, Adriantie L., 1761), especially on and near the top and edge and the west face. Sometimes, however, the lamination has not allowed any decay (*e. g.*, Geljam C., 1754). In both cemeteries, however, the decay at its worst has split up the stone, but has little affected the sharpness of inscriptions.

St. Paul's Churchyard.—One variety of fine-grained sandstone predominates, dating from 1813 back to 1768. The finest-grained and most compact are often in perfect condition (J. J., 1768), but many coarser or more laminated stones, and sometimes fine and compact stones, are very badly split, and show exfoliation near the ground (A. Van B., 1813)—sometimes with fissures across the stone (J. A., 1813). The splitting begins, as usual, near the west face and near the edges.

LIGHT-COLORED SANDSTONES.

Nova Scotia Sandstone.—In regard to this name, I have indicated already, but it is fair to explain more fully here, that it originated many years ago, when grindstone-dealers obtained their supplies from some small surface-quarries located in and near Nova Scotia. As that stone was of a yellow color, the stone-trade has persisted ever since in calling every light-colored stone coming from anywhere in that section, " Nova

Scotia stone." However, 95 per cent. of the imported stone is derived from New Brunswick (probably 85 per cent. from Dorchester, N. B.), and the remainder from Nova Scotia and other points. The popular name has been applied to light-colored stones of every quality, quarried at various points of Eastern Canada, over a wide section of country, hundreds of square miles in extent, and variously worked out at tide-level, under tide-water from exposed reefs running out into the sea, or, as at Dorchester, N. B., from a hillside 900 feet high and a quarter of a mile from tide-water. The small quarries usually work out only such stones as they can obtain from outcropping ledges and boulders, and these are apt to be of bad and varying color, more or less full of iron and other defects; for example, the surface-quarries of Hillsboro, N. B., long since abandoned, used in the houses in 42nd street near Madison avenue, in Second avenue near 55th street, some of the bridges in Central Park, etc. At the quarries of Dorchester, N. B., it is stated that from 35 to 50 feet of inferior rock and debris are first stripped off to reach the sound rock which is sent to this market. The introduction of this stone into the city as a building material has been too recent to allow any measure of its durability. A little exfoliation may be however distinguished near the ground-line, and on the sides and posts of stoops, in many cases. Also, in panels, under heavy projecting mouldings, cornices, etc., where the sun has no chance tor each and dry up the dampness, the stone moulders away slightly over the surface. In the cemeteries it is rarely or never used; in one example, possibly of this material, in St. Paul's churchyard (W. J. M., 1841), the decay is plainly beginning around the carvings. The discoloration of good varieties of the stone would be very slow to affect vertical surfaces, properly protected by drips; but on sloping, horizontal, or shaded surfaces, especially near the street-level, street-dust is sure to lodge and cling, all the more after the surface becomes roughened by a slight disintegration; while the rough usage to which the stone of balustrades and stoops is always subjected in a busy street, renders this, as well as all other soft varieties of freestone, liable to chipping as well as offensive discoloration (*e. g.*, in the courses, trimmings, and posts of the church on the corner of 42d street and Madison avenue, etc.) and unsuitable for use near the ground-line.

Ohio Sandstone.—The buff variety from Amherst is said to contain "97 per cent of pure sand." Buildings constructed of this material in this city since 1857 (*e. g.*, on the corner of Barclay street and Broadway, on the corner of Howard and Crosby streets, etc.), show no decay, but only discoloration. In other instances (*e. g.*, rows of houses on 50th street, west of Fifth avenue, on Madison avenue

between 34th and 43d streets, etc.) the blackened discoloration and frequent chipping of edges of the soft stone are quite offensive. On the other hand, it must be admitted that a stone which cleans itself, by the disintegration of its surface, the grains dropping out and so carrying away the dirt, as in the poorer and softer varieties of brown-stone or of Nova Scotia stone, is by that very action still more objectionable from its want of durability; and the discoloration of the Ohio stone is offset, at least in part, in the best varieties, by their hardness and promise of durability.

Medina sandstone.—This material is of recent introduction (*e. g.*, Baptist church on 57th street, west of 6th avenue), and its true durability cannot yet be estimated.

Bluestone (graywacke).—This stone is yearly coming into more general use, and, though somewhat sombre in tone and difficult to dress, seems likely to prove a material of remarkable durability. In one building in 24th street, between Madison and Fourth avenues, its condition appears to be excellent, after fifteen years exposure, perfectly retaining the tool-marks. The variety reported to come from the Wyoming valley (*e. g.*, in the building on the north side of Union Square) is really derived, as I am informed by Prof. H. L. Fairchild, from Meshoppen, Penn.

In this connection, we may refer to the experiments made by Dr. Hiram A. Cutting, of Vermont, on a series of American sandstones, in regard to specific gravity, weight, absorptive power, and resistance to fire. The results on varieties like those used in New York City are quoted in the following table (*The Weekly Underwriter*, 1880, Vol. XXII., p. 288):

Local Name.	Locality.	Specific Gravity.	Weight of one Cubic Foot, lbs.	Ratio of Absorption.	Heated at 600° F.	Heated at 800° F.	Heated at 900° F.	Heated at 1000° F.	Heated at Higher Temperatures.
Freestone	Portland, Conn.	2 380	148.7	1+27	Not Injured.	Not injured.	Friable.	Tender.	Ruined.
Freestone	North of England	2.168	135 5	1+27		"	Cracks badly.	Spoiled.	
Montrose Stone	Ulster County, N. Y.	2.661	166.3	1+314		"	Not injured	Slight injury	Stands well.
Freestone	Belleville, N. J.	2.350	146.8	1+27		"	Cracks.	Friable.	
Freestone	Nova Scotia	2 424	151.5	1+240		"	"	"	
Carboniferous Sandstone	Br. Philips, N. S.	2.353	147.0	1+19		"	Crumbles.	Cracks and crumbles.	
Freestone	Dorchester, N. B.	2.363	147 7	1+26		Cracks.	Cracks and crumbles.	"	
Berlin Stone	Cleveland, O.	2.210	*138.1	1+22		Not injured.	Slight cracks		Stands well.
Berea Stone	Berea, O.	2.254	*140 8	1+20		"	"	Crumbles.	"
Amherst Stone	Amherst, O.	2.200	*137.5	1+18		"	Changes color.	Friable.	"
Brownstone	Hammellstown, Pa.	2 346	146.6	1+28		"	Cracks.	Crumbles.	
Potsdam Sandstone	Beauharnois, Quebec	2.512	157.0	1+38		"	"	"	

* It is claimed that these figures understate the true weight, which is said to approximate 155 pounds.

LIMESTONE.

The coarse fossiliferous stone from Lockport owes its rapid disintegration within ten years, wherever used in this city, in part to its careless arrangement in masonry. Thus, in the building of the Lenox Library, at 70th street and Fifth avenue, about 40 per cent of the material is set on edge, *e. g.*, the alternate receding courses of the ashlar, trimmings of apertures, gate-posts, etc.; so also, in part, in the stone used in the Presbyterian Hospital. The oolitic stone from Ellitsville, Indiana, shows an almost immediate and irregular discoloration, said to be produced by the exudation of oil. The oolite from Caen, France, has also been used in many buildings, and, unless protected by a coating of paint, has shown decay in several instances. Mr. G. Godwin, of London, has stated (Soc. of Arts, 1881,) that "the Caen stone which was sent to this country (England) could not now be depended on and ought not to be used for external work." The extensive decay of this, with other oolitic and magnesian limestones, in the walls of Westminster Abbey, has recently caused great alarm and will necessitate the renewal of its outer masonry at enormous expense.

One of the most thorough investigations, in regard to the porosity of a series of American building-stones, was made by Dr. T. S. Hunt in 1864, and with the following conclusion (Chem. and Geol. Essays, p. 164):

"Other things being equal, it may probably be said that the value of a stone for building purposes is inversely as its porosity or absorbing power." From the results given on 39 specimens, the following may be here quoted as pertinent to stones used in New York City:

No. of Specimens.	Absorption Percentage.
1. Potsdam sandstone, hard and white.	0.50— 3.96 (usually about 1)
2. Medina sandstone.....	3.31— 4.04
3. Ohio sandstone.....	9.59—10.22
3. Caen limestone	14.48—16.05

Of course the proviso, "other things being equal," covers a great deal of important ground, including the solvency of the material of a stone in the acidified rain-waters of a city. Some of the most impervious and non-absorbent readily decompose; while others, which are porous or even cellular, may afford an excellent resistance to decay. But judged in regard to both points, porosity and solvency, the Caen stone may be safely rejected hereafter as unfit for our climate.

MARBLE.

The dolomitic marble of Westchester County has been largely employed in our buildings, and some idea of its character for durability may now be gained. A fine-grained variety was used in the building

of the U. S. Assay Office in Wall street; its surface is now much discolored, and the edges of many of the blocks show cracks. A variety of medium texture was employed in the hotel at the corner of Fulton and Pearl streets, erected in 1823; the surface is decomposed, after the exposure of exactly sixty years, with a gray exterior, in a crust ⅛ to ¼ inch in thickness, soft and orange-colored in section. Many crystals have fallen out of the surface on the weathered eastern face, producing a pitted appearance. A very coarse variety has been used in the Bank-building at Thirty-second street and Broadway, in large part being set on edge; very many of the blocks are more or less cracked, even in the highest story. In the U. S. Treasury building, in Wall street, a rather coarse dolomyte-marble, rich in tremolite and phlogopite, was used, the blocks being laid on bed in the plinth and most of the ashlar, but largely on edge in the pillars, pilasters, etc.; in the latter case vertical fissures commonly mark the decay, but even elsewhere a deep pitting has been produced by the weathering out of the tremolite. The marble used in many other prominent buildings has been improperly laid, *e. g.*, in both of the buildings of the City Hall, the Drexel building at the corner of Broad and Wall streets, the Academy of Design at 23d street and Fourth avenue, etc.

Cemetery at New Utrecht.—Here a very fine white marble is used in many stones, perhaps that of Carrara—a few stones dating about or a little before 1800. These are in excellent condition, but on the east face are much roughened.

Another variety is a tremolitic dolomyte-marble, white, fine to coarse in texture, probably from Westchester County. It is in fair to good condition, but the weathered tops, sides, and east faces of the stones are in a pulverulent state. Sometimes the west face is the one roughened, and the stone is split near it.

Stones of a white veined marble, probably from Vermont, date from 1853 back to 1828. They are in good condition, but the east face is pulverulent.

A blue marble (C. Groenendyke, 1797) and a black and white marble (N. G., 1795) are in excellent condition, but the eastern faces of the stones are decidedly roughened, the inscriptions remaining sharp and distinct.

Flatbush Cemetery.—Marble here predominates in two varieties. The stones of a fine white marble (Italian), date from 1859 back to 1809. They are generally in good to excellent condition, but their surfaces are more or less roughened, becoming pulverulent when dating from 1836. That of 1809 (N. R. C.), a horizontal tablet, is blackened by a minute lichen, *lepra antiquitatis* (also J. V., 1800).

The stones of a coarse tremolitic dolomyte-marble date from 1847 back to 1818. They weather grayish and become much roughened over the east face, top and sides, and sometimes over a third of the surface down the west face. Fissures in the edges of the stone begin after about 30 years exposure. The polish has survived for about 40 years on the faces of some stones of this class, even when the edges are disintegrated. Near the ground for a foot the polish remains even much longer, *e.g.*, the double stone of Femetie and Peter Stryker (1730).

St. Paul's Churchyard.—The stones here date from 1851 back to 1798, and consist of a coarse white marble. It weathers grayish white, and becomes roughened. Only a small proportion of the stones are split. About one-tenth have their inscriptions entirely obliterated, and this fact, due doubtless to the acid rain-waters of the city, was not observed in the suburban cemeteries; in one case (A. W., 1851) it has been largely affected in a little over 30 years.

The horizontal tablets, supported on masonry, which has partially settled (*e.g.*, J. G., 1821), generally show a slight curvature in centre, only in part possibly produced through solution by standing rain-water.

Dolomieu first made the observation on an Italian marble called Betullio, that it possessed a degree of flexibility allied to that of the itacolumyte of Brazil. Gwilt states (Encyc. of Arch., p. 1274):

"Some extremely fine specimens of white marble are to be seen in the Borghese Palace at Rome, which, on being suspended by the centre on a hard body, bend very considerably. It is found that statuary marble exposed to the sun acquires, in time, this property, thus indicating a less degree of adhesion of its parts than it naturally possessed."

In the white marble-veneering of the facade of St. Marks, Venice, the same effect has been observed by Mr. C. M. Burns, Jr., in the lower half of a slab of veined marble, two inches thick, on the south side of the northernmost of the five portals, just behind the columns and about five feet from the pavement. The slab is eleven feet and two inches long, and one foot and six inches wide; it is hung to the backing by copper hooks driven into the brickwork, but the lower part, for a distance of five feet and seven inches, bulges out two and three-quarter inches from the backing. "The exposure is directly westward, and I found that it became decidedly warm in the afternoon sun, while the backing would be likely to keep its temperature lower. Though the outer surface is somewhat weatherworn, I could not find the slightest

tendency to fracture in any part." (*The Am. Arch. and Build. News*, 1882, p. 118).

Also at the palace of the Alhambra, in Grenada, Spain, one of the two doors that have been christened "La Mezquita," exhibits an ancient facing of three slabs of marble, the upper resting as a lintel upon the two others, which form uprights, eleven feet in height, nine inches in width, and only two and one-half inches in thickness. At eighteen and one-half inches from the top of the door, the slab on the right begins to curve and to detach itself from the wall, attaining the distance of three inches at about three feet from the bottom. From a subsidence of the material of the wall, an enormous thrust has been exerted upon the right, and the marble, instead of breaking or of rupturing its casings, has simply bent and curved as if it were wood. (*La Nature*, 1882.)

I have also been informed at Sutherland Falls and other quarries near Rutland, Vermont, that the bending of thin slabs of marble, exposed to the sunshine in the open air and accidentally supported only at the ends, has been there repeatedly observed.

Fleurian de Bellevue discovered a dolomyte possessed of the same property in the Val-Levantine, of Mt. St. Gothard. Dolomieu attributed the property to "a state of desiccation which has lessened the adherence of the molecules of the stone," and this was supposed to be confirmed by experiments of De Bellevue, who, on heating inflexible varieties of marble, found that they became flexible.

This change, however, cannot be connected with the remarkably small content of water existing in marbles, but with a peculiarity of their texture, which has been briefly discussed by Archibald Geikie (Proc. Roy. Soc. Edinb., 1880), in an interesting investigation on the decay of the stones used in Scotch cemeteries. He has pointed out that the irregular and closely contiguous grains of calcite, which make up a white marble, are united by no cement, and have apparently a very feeble coherence.

It appears to me probable also that their contiguous crystallization has left them in a state of tension, on account of which the least force applied, through pressure from without or of the unsupported weight of the stone, or from internal expansion by heat or frost, produces a separation of the interstitial planes in minute rifts. Such a condition permits a play of the grains upon each other and considerable motion, as illustrated in the commonly observed sharp foldings of strata of granular limestones, without fractures or faults. In such cases, also, I have observed that the mutual attrition of the grains has been sometimes sufficient to convert their angular, often rhomboidal, original contours into circular outlines, the interstices between the rounded grains being evidently filled up by much smaller fragments and rubbed-

off particles; *e. g.*, in the white marble of the anticlinal axis at Sutherland Falls, Vt.

These results are confirmed by the appearances, familiar to all lithologists, in the study of thin sections of marble, the latent interstices between the grains of calcite having been often developed by the insinuation of films and veinlets of iron-oxide, manganese-oxide, etc. While a polished slab of marble, fresh from the stone-yard, may not be particularly sensitive to stains; after it has been erected and used as a mantelpiece over a fire-place, its increased absorbence for ink, fruit-juices, etc., becomes strongly marked. On this property are founded the processes, always preceded by heat, for the artificial coloring of marbles.

In the decay of the marble, largely Italian, in the atmosphere of Edinburgh, Geikie has recognized three phases:

1. Loss of polish, superficial solution, and production of a rough, loosely granular surface. This is effected, Geikie states, by "exposure for not more than a year or two to our prevalent westerly rains." The solution of the surface may sometimes reach the depth of about a quarter of an inch, and the inscriptions may become almost illegible in sixteen years.

In our own dry climate, however, these results do not appear. The polish often survives ten years in our city cemeteries, and even for over half a century near the ground, in the suburban cemeteries; in one instance, at Flatbush, it has remained intact for over 150 years, on the tombstone of F. and P. Stryker, dated 1730. Inscriptions are decipherable in St. Paul's churchyard back to the date of 1798, but about one-tenth are illegible or obliterated; the latter effect was never seen in a single instance on the suburban stones, and is evidently due to the acid vapors in the rain-waters of the city.

2. Incrustation of the marble with a begrimed blackish film, sometimes a millimeter in thickness, consisting of town-dust, cemented by calcium sulphate, and thorough internal disintegration of the stone, sufficient, after a century, to cause it to crumble into powder by very slight pressure.

Neither the crust nor any deep disintegration has been observed in the oldest marble-tombstones in the cemeteries of New York; their absence is plainly attributable to the inferior humidity of our atmosphere and the absence of smoke from soft coals.

3. Curvature and fracture, observed in slabs of marble, firmly inserted into a solid framework of sandstone. This process consists in the bulging out of the marble, accompanied with a series of fractures, and has been accomplished by expansion due to frost. Tombstones are never constructed in this way, in our cemeteries; but the curvature of

horizontal slabs, observed in St. Paul's churchyard, produced by the sagging of the supporting masonry beneath the centre of the slab, is simply indicative of the flexibility of the material.

Geikie states: "The results of my observations among our burial-grounds show that, save in exceptionally sheltered situations, slabs of marble, exposed to the weather in such a climate and atmosphere as that of Edinburgh, are entirely destroyed in less than a century. Where this destruction takes place by simple comparatively rapid superficial solution and removal of the stone, the rate of lowering of the surface amounts sometimes to about a third of an inch (or roughly 9 millimetres) in a century. Where it is effected by internal displacement, a curvature of 2½ inches, with abundant rents, a partial effacement of the inscription, and a reduction of the marble to a pulverulent condition, may be produced in about forty years, and a total disruption and effacement of the stone within one hundred. It is evident that white marble is here utterly unsuited for out-of-door use." My own conclusions, from observations in New York, is that, in the cemeteries within the city, the polish on vertical slabs is usually destroyed in about ten years; that the inscriptions are only in small part effaced within thirty to fifty years, and are for the most part perfectly legible on the oldest tombstones, dating 1798; and that, although the reduction of the surface to a loose granular condition may reach the depth of ten millimetres, the actual lowering of the surface seldom exceeds five or six millimetres, the internal disintegration is never sufficient to affect sensibly the strength of the stone during the periods of exposure which have been noted, and a slight flexure, sometimes to the amount of twelve or fifteen millimetres, sometimes affects the centre of horizontal slabs, two metres in length.

In the cemeteries without the city, the polish may often survive near the ground, on the faces of vertical slabs, for over one hundred and fifty years; the granulation of the surface rarely exceeds a depth of three or four millimetres; and all the inscriptions remain perfect on the oldest vertical tombstones, suffering partial effacement only on horizontal slabs.

Although these facts show the far greater durability of marble in our dry and pure atmosphere, the frequent obliteration of inscriptions, the general, and often rapid, granulation of the surface, and the occasional fissuring of slabs, show that the decay of marble—in the varieties hitherto long used in New York City—is steady, inevitable, and but a question of time; and with Geikie, I, too, am convinced that, if unprotected, such materials are utterly unsuited for out-of-door use, at least for decorative purposes or cemetery-records, within the atmosphere of a city.

GRANYTE.

The bluish variety from Quincy, Mass., has been used in many buildings and rarely shows as yet many signs of decay. In the U.S. Custom House on Wall street, most of the huge blocks appear laid "on bed," but, nevertheless, show some pitting in places, by the attack and partial removal of the larger grains of hornblende. In the church at Fourth street and Lafayette Place, erected in 1830, a little exfoliation has been produced by street-dust on the faces of some steps. In the Astor House, at Barclay street and Broadway, no decay was observed.

In the fine-grained granyte from Concord, N. H., employed in the building on the southeast corner of Twenty-third street and Sixth avenue, many of the blocks are set on edge, but the only change yet seen is that of discoloration by street-dust and iron-oxide from the Elevated Railway.

The light-colored and fine-grained granyte of Hallowell, Me., has been used for the construction of the City Prison, the Halls of Justice or "Tombs," in Centre street. This stone consists of a white feldspar, which predominates, a greyish-white quartz, which is abundant, and a considerable quantity of a silvery white mica, thoroughly intermixed. The rock possesses several properties—fineness of grain, homogeneity of structure, and freedom from iron, as shown by the color of the feldspar—likely to render it durable; the only unfavorable conditions are the predominance of feldspar and the laminated structure. The rock is a granitoid gneiss, with lamination often clearly marked; these markings at once show to the eye that most of the blocks are set, not on bed, but irregularly on edge.

The building is square and occupies an entire block. On a study of the weathering, the south face was found to present an exfoliation to the depth of one-eighth to one-fourth of an inch at many points, up to the very summit of the building, particularly on the sides of the pillars at the southeast entrance, on the ashlar near the southwest gate, under and over the cornice and string pieces. In some places the stone was loosened or peeled off in sheets of the area of a square foot. The west front presents much exfoliation all over the surface, though always thin; it seems to begin chiefly along and near the joints. In places, fragments have separated from the corners of the blocks. The north front exhibits very little exfoliation; so also the east front, in a few small scattered spots.

The exfoliation appears to be the result directly of the sun's heat, exerted most intensely on the southern and western sides of the building. An examination of the disintegrated material shows but little decomposition; a little kaolin may be distinguished in films, but the bulk of

the feldspar, the weakest constituent, remains with bright facets, without change in color or lustre. It is by no means characteristic of the "maladie du granit," first described by Dolomieu and later studied by Dr. T. Sterry Hunt; but here the action seems to be mainly and simply a disintegration of the grains, initiated by expansion under the sun's heat, during the summer, and developed by the expansion caused by frost during the winter. An architect of the city recently stated that "he had built several large granite offices and considered Quincy granite the most durable of all building material. He thought the weathering of granite would hardly amount to one-thirty-secondth of an inch in a hundred years. According to that calculation many buildings might hope for a longer span than the thousand years spoken of by the professor."

However, it is a well-known fact that the weathering of granyte does not proceed by a merely superficial wear, which can be measured or limited by fractions of an inch; but by a deep insinuation along the lines of weakness, between grains, through cleavage-planes, and into latent fissures. Thus, long before the surface has become much corroded or removed, a deep disintegration has taken place by which large fragments are ready for separation by frost, from the edges and angles of a block. When directly exposed to the heat of the sun, an additional agency of destruction is involved, and the stone is suddenly found ready to exfoliate, layer after layer, concentrically. As yet we have little to guide us in the estimation of durability in years, since the best known granyte monuments are those which have been exposed to the exceptionally mild climate of Egypt; but even there some exfoliation has been noticed, *e. g.*, on the inner walls of the so-called Temple of the Sphynx.

In the cemeteries within the city and on Long Island, much granyte is now used in slabs and monuments, but its introduction has been everywhere of too recent a date to afford any measure of its durability. Geikie remarks: "traces of decay in some of its feldspar crystals may be detected, yet in no case that I have seen is the decay of a polished granite surface sensibly apparent after exposure for fifteen or twenty years. Even the most durable granite will probably be far surpassed in permanence by the best of our silicious sandstones. But as yet the data do not exist for making any satisfactory comparison between them."

GNEISS.

The oldest building in this city, in which this material has been used, appears to be that of St. Matthews Lutheran Church, on the northeast corner of Broome and Elizabeth streets, erected in 1841. The stone is the micaceous gneiss, in part hornblendic, from excavations on the

island, with trimmings, string-pieces, etc., of brown stone, the latter, as usual, being in a state of decay. On the west front, the gneiss is in excellent condition, occurring in small blocks, mostly laid on the bedding-plane. In the south front, many of the quoins are set on edge and are much decayed along the joints, sometimes with splitting or exfoliation, fracture of corners, and irregular chipping out of the surface to the depth of one-half to one inch below the level of the projecting cement-joints.

GENERAL CONCLUSIONS.

If a rough estimate be desired, founded merely on these observations, of the comparative durability of the common varieties of building-stone, used in New York city and vicinity, there may be found some truth in the following approximative figures for the "life" of each stone, signifying by that term, without regard to discoloration or other objectionable qualities, merely the period after which the incipient decay of the variety becomes sufficiently offensive to the eye to demand repair or renewal.

	Life, in Years.
Coarse brownstone	5–15
Laminated fine brownstone	20–50
Compact fine brownstone	100–200
Bluestone	Untried, probably centuries.
Nova Scotia stone	Untried, perhaps 50–200
Ohio sandstone, (best silicious variety),	perhaps from 1 to many centuries.
Limestone, coarse fossiliferous	20–40
Limestone, fine oolitic (French)	30–40
" " (American)	Untried here.
Marble (*Dolomyte*,) coarse	40
" " fine	60–80
Marble, fine	50–200
Granyte	75–200
Gneiss	50 years to many centuries.

Within a very few years past, it has become frequent to introduce rude varieties of rusticated work into the masonry of buildings in this city, or to leave the stone rough and undressed in huge blocks, especially in the basement or lowest stories, where it is under close and continuous inspection, and the results of its decay will be disguised by its original rough surface. Although there are certain large buildings in which such a massive treatment of stone may be appropriate, its common use, with stones of known feebleness or lack of durability, is a disingenuous evasion of responsibility and a mere confession of ignorance, want of enterprise, and despair, in regard to the proper selection of building material and in regard to its protection.

Finally, it may be pointed out that many of the best building stones of the country have never yet been brought into this city; *e. g.*, silicious

limestones of the highest promise of durability, allied to that employed in Salisbury Cathedral: refractory sandstones, like some of those of Ohio and other Western States, particularly fitted for introduction into business buildings in the "drygoods district," storage houses, etc., where a fire-proof stone is needed; and highly silicious varieties of Lower Silurian sandstones, such as occur near Lake Champlain, quartzytic and hard to work, like the Craigleith stone of Edinburgh, but possessing the valuable qualities of that fine stone, in resisting discoloration, notwithstanding its light color, and in remarkable resistance to disintegration.

As it is, we have many and need many varieties of stone for our various objects, but do not know how to use them. It is pitiable to see our new buildings erected in soft and often untried varieties of stone, covered with delicate carvings of foliage and flower-garlands, which are almost certain to be nipped off by the frost before the second generation of the owner shall enter the house. It is now time for one who loves stone to express his indignation at the careless and wasteful way in which a good material is being misused.

DISCUSSION.

Mr. F. Collingwood remarked on the durability of the stone (Trenton limestone) used in Montreal, and on the general need of well established rules for the selection of stone. He suggested for investigation, the subject of the effect of internal moisture on cements, *i. e.*, whether the slow percolation of rain-water through the cement in the joints of masonry, *e. g.*, in an arch, is likely to injure the integrity of the structure, producing serious damage by the disintegration of the cement.

A Visitor, a practical builder, stated that at present, in New York, the struggle of competition tended to produce satisfaction with temporary effects, and the mere question of cost was at the bottom of the hasty selection and cheap construction. Nevertheless, as nice workmanship in stone could be seen, and was being executed in New York to-day, as in any other place in the world. He asked for further explanation, and felt it due to the trade to say that stones were generally treated badly from ignorance rather than from intention. It was the duty of those who know all about these things, to inform those who had to build and work the stone all about its properties and capabilities, and then some good result might ensue. He himself felt the necessity of further knowledge

on this important subject, and was sure that most of those in the trade felt as he did.

On invitation, Dr. T. STERRY HUNT observed that frost was the main agent of the disintegration of stone in our climate, often suddenly succeeding the moistening of the material by long rains, and thus producing violent expansion and crumbling. In England, no such extremes occurred. However, in visiting York Minster, a few years ago, he found the workmen engaged in repairing the magnesian limestone at one of the gates. He had climbed up the ladder, and, on examination of the stone, found a remarkable disintegration near the middle, to the depth of one or two inches, by which bars of the rock projected, marking the less absorbent layers.

As to the granytes, that of Hallowell, Me., and that vicinity, is only a granytoid gneiss, and not as compact as a true granyte; its exfoliation he knew to be a mere disintegration, favored by the greater porosity of its texture. The material of the granyte obelisk in Central Park is one likely to offer great resistance to disintegration and chemical decay, as the similar obelisks at Rome and Paris seem to show little or no effect of weathering.

The subject was further discussed by Messrs. BERG, TROTTER, and by the PRESIDENT, who expressed a cordial welcome to practical men to attend the meetings of the Academy, and to contribute to their interest through the valuable materials acquired by their experience.

May 7, 1883.

The President, Dr. J. S. NEWBERRY, in the Chair.

Thirty-three persons present.

Mr. B. B. CHAMBERLIN exhibited some curious concretions of pyrite from the clay-pits at Amboy, N. J. They presented oval, spherical, and sometimes annular forms, with radiated structure, or with finely granular nuclei and beautifully crystallized envelopes.

Prof. D. S. MARTIN remarked that similar concretions, sometimes exceedingly handsome and with curved crystals, occurred in the white clay beds of New Jersey, belonging to the base of the Cretaceous, and in the plastic clays of the same horizon, which may perhaps represent the Wealden in this country.

The PRESIDENT stated that these specimens were certainly con-

cretionary, and similar to those found in the clays of Ohio, the Connecticut Valley, etc. A peculiarity of this mineral is the readiness with which some specimens oxidize, while others, apparently similar in all other respects, remain brilliant. Few more beautiful minerals ever enter a collection; but many of the specimens of pyrite in the cabinet of the School of Mines, particularly those from Schoharie, N. Y., decomposed rapidly, absorbing oxygen and water, thus forming sulphuric acid, which has destroyed labels and trays, and has even cut through the bottom of the drawer in which they were placed. Others, like those from Roxbury, Conn., and from certain gold mines of Colorado, have remained unchanged, though for years lying in a room over the chemical laboratories. No facts in chemical geology were more interesting and mysterious than those connected with pyrite: such as its close companionship with gold, the conditions of which have not been determined; its unchangeableness in some cases, its destructibility in others. Sometimes its crystals or concretions are completely changed to limonite, with not the least change of form or markings; sometimes, by oxidation, it is converted into sulphate of iron, which is washed away, leaving cubical cavities, or a spongy mass of quartz; and sometimes even the iron has disappeared, leaving the cavities lined with sulphur. These differences have not yet been satisfactorily explained, and they constitute an inviting subject of investigation for the chemist and mineralogist.

Dr. Newberry had noticed that the pyrites so common in coal, and pyrite replacing wood, are particularly prone to oxidation, the concretions in clays liable to it, and the brilliant crystallizations in mineral veins and in metamorphic slates less so.

Prof. D. S. Martin observed that these specimens do decompose with wonderful readiness at Keyport, and in a peculiar way, where exposed to the salt water, the ordinary alteration into sulphate of iron being there replaced by a change into limonite, apparently through some action of the sea-water, the pebbles in the vicinity being also encrusted by limonite.

The Corresponding Secretary read letters from Dr. Weissbach, of Freiburg, Prof. Jannetaz and M. Emile Bertrand, of

Paris, and Prof. A. D'Achiardi, of Pisa, accepting their election as Corresponding Members of the Academy.

Prof. A. R. Leeds exhibited a crystalline body obtained from human milk. The examination of the ratio between the constituents of milk afforded a subject of much interest and importance. In the course of an investigation of this subject, he had recently procured, through Doctors Thomas and K. Parker, sixty specimens, of two ounces each, of human milk. The albuminoid substances were first precipitated by a salt of copper, the filtrate evaporated, and from this residue an etherial extract was prepared. The ether carries into solution an organic fatty salt of copper which was not present in cow's milk. In the latter, the fats are colorless and solid at ordinary temperatures; in human milk, they are liquid. The object of his investigation was to determine the exact nature of the fatty bodies in human milk, and these results appeared to show that there may be a new fat which forms a crystalline salt soluble in ether. These fats must be numerous, but hitherto we have been content to know their general nature.

Dr. N. L. Britton read a paper, illustrated with specimens and drawings,

ON THE FINDING OF PREHISTORIC INDIAN SKELETONS AT FAR ROCKAWAY, LONG ISLAND.

The skeletons here described were discovered in an excavation made for the cellar of a new house, erected for Mr. W. T. Bailey in September, 1882. The locality is locally called "Breezy Point," and is one and one-half miles west from the Far Rockaway Station on the Long Island Railroad. The cellar is 225 feet from the shore of a part of Jamaica Bay, and about five feet above high water mark.

Nine skeletons were unearthed, six of them from near the southeastern corner of the house, and three from along the eastern side. They had evidently been thrown into holes without much or any regard for the manner of burial. The positions of the former holes were plainly indicated by the difference in color of the materials filling them, and that of the undisturbed soil. The former was quite a dark brown; the latter, a light yellow.

The natural soil of the vicinity is the pre-glacial yellow sand and gravel drift, which is indistinctly stratified. The holes were filled with this soil for the most part, but mixed with shells of clams and oysters.

Some rude pottery was taken out in fragments. The brown coloration was probably derived from the decomposition of the bodies.

Of the six skeletons found in the larger hole, three had already been removed piece-meal, when he visited the spot on September 9th. They were about two feet from the surface of the ground. He found three still remaining in this hole. One was the skeleton of a very large man, and measured six feet and eleven inches in length, as it lay in the ground. The legs were drawn up, bringing the knees even with the breast, and the hands were seemingly clasped at a level with the face. This skeleton he secured and brought with him.

A child lay to the left of this man, and a fully grown person to his right; the bones of both were badly decomposed. The bones had all been removed from the smaller hole, and he was informed that these had all belonged to adults.

Shell heaps, composed of single valves of *Venus mercenaria*, the hard clam, of *Ostrea borealis*, the oyster, and of *Modiola plicatula*, occur all along the shore in the vicinity; these are as much as three feet in thickness in places, and twenty feet wide.

His attention was first called to these skeletons by Mr. Wm. A. Torrey.

DISCUSSION.

In answer to an inquiry, Dr. BRITTON stated that a tomahawk and several arrow-heads had been dug up in the vicinity.

Professor MARTIN remarked that the pottery showed the type of incised ornamentation, effected by some small hard point.

The PRESIDENT referred to similar collections of shells at many other points along the Atlantic coast. Some on this side of the peninsula of Nova Scotia were found to contain the bones of the great auk and of the walrus. Walrus bones have also been discovered further south, near Long Branch, but were partially silicified and probably much older. Many kjoekken moeddens also occur on the west coast of Florida, and have been described by Professor JEFFREYS WYMAN and others. One of these near Cedar Keys, which had been examined by Dr. NEWBERRY, is half a mile long, twenty to forty feet high, and covered with large live oaks and palmettoes. Further west, along the Gulf coast, the shell mounds are largely composed of *Gnathodon*, and have furnished the material for the famous shell roads. They are also found in the interior, and one on the Tennessee, near Chattanooga, gives its name to Shell Mound Railroad Station. The shells which compose these are

mostly species of *Unio.* One near Palatka, Florida, is chiefly made up of univalves, belonging to a species of *Unio* (*Campeloma*).

The shell mounds of the Gulf coast are apparently the work of a peculiar people, who subsisted chiefly on mollusks; and the Atlantic coast mounds are also probably the work of maritime tribes, but not certainly the same with those living on the Gulf. They had this in common, however, that both were cannibals. This is learned from the condition of the human bones found in the mounds, some of which are split longitudinally for the extraction of the marrow.

The date of the shell mounds is uncertain, but we have evidence that they belong to a period long anterior to the advent of the whites. They are generally overgrown by the forest, and bear trees of many hundred years of age, so that the process of accumulation ceased hundreds of years ago. The Florida shell mounds exhibit another feature indicative of age, *i. e.*, they are in part composed of shells which are rare in the vicinity or not found there, and the specimens obtained from the shell mounds are often larger than any that can now be procured in that region. The early narratives of the experience of the whites in the Gulf mention the Caribs as the most important Indian tribe met with. These were maritime in their habits, living largely upon mollusks and fish, and were cannibals. It is quite possible therefore that the builders of the shell heaps on the Gulf coast were Caribs, who may have had formerly a more extended range than when seen by the Spanish historians. A skull, taken by Dr. NEWBERRY from a shell mound near Cedar Keys, must have belonged to a man of good size and creditable cranial development. It exhibited a character common to most of the crania of these coast tribes, namely, that the under jaw projected so that the upper and under teeth were in direct opposition, and worn down around the whole half-circle with great regularity. It is not uncommon to find sets of teeth nearly complete, but worn quite to the alveolus. This extensive wearing away of the teeth was probably caused by the use of food containing much silica, either that was not properly freed from sand, or more likely the seeds of plants which contained considerable silica in their tissues. The elongation of the under jaw gave greater space for the teeth than orthognathus races have. By the use of tender and cooked food, the work of the jaw in mastication has been di-

minished; and as nutrition is measured by action, and growth by nutrition, the jaw of civilized man is shorter, and the posterior molar (wisdom-tooth) appearing last, is cramped for room, imperfectly developed, and usually temporary. In the jaws of the shell mound people, the wisdom-tooth was one of the largest and most serviceable of the series.

The Far Rockaway skeletons were evidently many hundred years old—how many, none can say. The bones were extremely light and friable; but this is as often the result of special conditions as of time. From the relations of the skeletons to the shell heaps, it may fairly be inferred that they were the remains of the shell mound builders, and were consequently cannibals; but if so, the conditions of the bones indicate that they were rather the eaters than the eaten. The skeleton procured by Mr. BRITTON was that of a man fully six feet in height, well-proportioned, and with good cranial development.

Mr. B. B. CHAMBERLIN referred to a shell-mound which existed some years ago at Tarrytown, on the Hudson river, 28 miles from the coast. It was mostly made up of oyster shells, containing many arrow-heads, but has since been removed by the extension of a neighboring brickyard.

Prof. MARTIN stated that the late Mr. Leavitt had spoken of a shell-mound which formerly existed near Inwood, on New York Island. In New England large shell-mounds occur, such as one at Damariscotta, Maine, thirty feet in height above the river, but which was quarried several years ago for lime. In this the common shells were those of the oyster, but very large, long and narrow, a species which no longer exists there.

Dr. BRITTON remarked that there was formerly a shell-mound, which was a constant resort for collectors of arrow-heads, at Old Bridge, N. J., ten miles up the Raritan and four miles distant from the river.

Dr. JULIEN referred to the very numerous shell-mounds upon the salt-marshes all along the New Jersey coast, and some of which had been partially or wholly submerged, in the progress of the subsidence of that region, forming shell-banks beneath the bays and salt-creeks, as near Barnegat, Manahawkin, Tuckerton, etc. In the early settlement of that country, tribes of Indians were known to make

periodical visits to the coast, collecting vast quantities of clams and oysters, drying and stringing them, and thus transporting them inland. It would therefore appear that, in that region, the accumulation of shells did not particularly imply the consumption of mollusks by the Indians who gathered them, as they were probably distributed in the interior.

In reply to an inquiry, the PRESIDENT stated that there was nothing characteristic about the fragment of pottery found at Rockaway. It is extremely rude, this mode of ornamentation being very common on such Indian pottery, having been effected by a small point, by the dentated edge of a shell, or by a cord.

Dr. DA COSTA stated that pottery of this character was found abundantly near Cape Truro, and was not regarded as very ancient.

A MEMBER pointed out that the position of the skeleton, with the knees bent forward, so as to touch the chin, was a common one in Indian burial. It was noteworthy that the skeletons occurred in groups of three, as if the wife and child had been sacrificed at the grave of the warrior.

Dr. BRITTON replied that only one skeleton, the largest, was drawn up in this position, the others lying extended. The three skeletons of the upper group did not lie at the same level, as if they had been irregularly thrown in.

The PRESIDENT remarked on the frequency of burial in the sitting posture, to which reference is made in Longfellow's lines on the "Skeleton in Armor," found at Newport, R. I. Elsewhere the bones are found extended, and, as in Europe, many have suffered cremation.

A paper was then read by Dr. JOHN S. NEWBERRY, on

SOME INTERESTING REMAINS OF FOSSIL FISHES, RECENTLY DISCOVERED.

The specimens, now exhibited to the Academy, are the teeth and dental plates of some new and remarkable fishes, from the Devonian rocks of Ohio and New York. One group represents parts of the dentition of large ganoids, which have up to the present time afforded no other portions of their bony structure. The others are plates which composed parts of the armor of a new placoderm, allied to *Coccosteus* and *Pterichthys*. Fuller descriptions with figures will eventually be given to the public, but in the meantime the following notes upon them are

submitted to the Academy, and will probably suffice for the identification of any similar fossils which may hereafter be found.

MYLOSTOMA, nov. gen.

Ctenodipterine ganoids of large size, of which as yet only the dentition is known. The teeth consist of strong and massive tables of bony tissue becoming more dense and resembling enamel above, and forming pairs in the upper and lower jaw. The dental plates of the lower jaw consist of long-oval or spatulate crowns, three to six inches in length by one to two inches in width, and half an inch or more in thickness, supported by strong, vertical, spatulate bones, which project downward and backward, terminating posteriorly in thin rounded margins. The upper surface of the crown of the inferior dental plates is raised into a more or less prominent tubercle or boss, which rises from the exterior margin a little anterior to the middle. The dental plates of the upper jaw are tables of dense tissue, apparently forming two or more pairs on each side of the median line. The largest of these is three inches in length, by an inch and a quarter wide in the widest part, somewhat triangular in outline, flattened where it rested on the probably cartilaginous floor of the cranium. It is about half an inch in thickness, the free surface somewhat irregularly excavated to receive the prominences of the opposing dental plates. Another of these palatal teeth is shorter and broader, with one margin concave, apparently for co-adaptation with the tooth previously described.

It is probable that we have not yet obtained all the elements in the peculiar dentition of this fish ; and the parts yet discovered are so peculiar and anomalous as to make it difficult to co-ordinate them satisfactorily with any hitherto known. The flattened tabular dental plates, which I have supposed formed the roof of the mouth, have a general analogy in form and texture with those of *Chimæra*, and, it is evident, are their analogues and functionally their representatives. Still the teeth of the under jaw, found with these and exhibiting the same microscopic structure, differ widely from any portion of the dentition of chimæroid fishes and exhibit a striking resemblance to the dental plates of the Dipterine ganoids. They evidently form pairs ; for we have the corresponding teeth of the right and left sides, and the triturating surface oval in outline, though wanting the radiating ridges of the Ctenodonts, seems to have occupied a corresponding position ; and they are mounted on heavy vertical supports which, except that they are flattened vertically instead of horizontally, correspond with the splenial bones which support the dental plates of *Ctenodus*.

The resemblance of the teeth, which I have supposed formed the

roof of the mouth, to those of *Ceratodus*, will strike any one who examines them ; and no other analogy in the whole range of ichthyic dentition suggests itself.

Until we shall obtain further information in regard to this strange system of dentition, it will be safest therefore to refer these fishes to the group which includes *Dipterus, Paledaphus, Ctenodus* and *Ceratodus.*

MYLOSTOMA VARIABILIS, N.

Inferior dental plates, ovoid, or short-spatulate in outline, 3 inches long by 1⅛ wide in the widest part; crown composed of dense bony tissue, becoming enamel-like near the surface, 6 lines thick anteriorly but thinner toward the narrow posterior end. Surface granular or roughened with a vermicular marking, raised, near the middle and on the outer side, into a strong, oblique tubercle or boss. Below, the anterior portion of the tooth is excavated into rudely concentric furrows, from the centre of which descends, beginning at the anterior third, the obliquely compressed splenial bone, which projects downward and backward, to the length of several inches, becoming 1⅝ inches wide at its widest part.

Considerable diversity is shown in the degree of irregularity of the crown surface in corresponding teeth. Three of these, nearly of the same size, show in one a rudimentary irregular boss near the outer angle ; another, the opposite tooth, rises in a strong furrowed, posteriorly depressed, obtuse tubercle, half an inch in height ; while the third, corresponding in position to the last, is a little shorter and broader, and the tubercle is latterly deflected and compressed, till it forms a blunt edge.

Still another and very imperfect tooth, of a smaller size, has a crown elliptical in outline and a blunted, furrowed tubercle, relatively much larger than either of the others. This smaller tooth varies so much from the others, with which it is associated, as to lead to the suspicion that the dentition of the lower jaw like the upper consisted of more than one pair of dental plates.

The dental plates of the upper jaw, in one or several pairs, are rudely triangular in outline, with a flattened or concave triturating surface, bearing, as do some of the inferior teeth, evidences of the wear occasioned by the prominent bosses of the opposing teeth. The surface of attachment of these dental plates to the cranium is flat or concave, and somewhat rough from the coarse cellular tissue of the bone. The sides are straight or beveled, apparently for co-adaptation, and, by their character, favor the conclusion that the

dentition consisted of many pairs of plates, constituting a tesselated pavement.

Like those of the associated species, the remains of this very remarkable fish are part of the fruit of the enthusiasm and indefatigable industry of Mr. Jay Terrell of Oberlin, Ohio, the discoverer of the great species of *Dinichthys* which bears his name, the only remains known of *Diplognathus* and various other interesting ichthyic fossils.

MYLOSTOMA TERRELLI, n. sp.

Inferior palatal teeth in pairs, each of which is spatulate in outline, with one margin nearly straight, the other strongly arched toward the exterior; length, 6 to 7 inches, by 1¼ inches in greatest breadth; crown composed of dense enamel-like tissue, 8 lines in thickness toward the front, and gradually thinning toward the narrowed posterior end. Triturating surface punctate or vermicularly roughened, slightly arched from front to rear, and rising into a low rounded boss near the external margin, where the tooth is broadest, and about one-third of the length from the anterior extremity. Below, the crown is supported by a strong bony keel which begins at the anterior fourth of the length and gradually descends backward until it has a width of 2½ inches, terminating in a thin irregularly rounded margin, 10 inches or more from the anterior extremity of the crown.

With all the other specimens of the genus, these teeth were discovered by Mr. Jay Terrell in the Huron shale on the banks of Vermi ion River, Ohio.

May 14, 1883.

The President, Dr. J. S. NEWBERRY, in the Chair.

Thirty-six persons present.

Mr. G. F. KUNZ exhibited a specimen of graphite, containing apparently over twenty per cent. of carbon, from a vein at Bloomfield, Morris county, New Jersey. The vein has been traced for a distance of four or five miles, and contains, in association with the graphite, pyrrhotite, apatite, loxoclase feldspar, and muscovite. A shaft was sunk upon it twenty years ago, but mining operations have been recently resumed at this locality, with promise of success.

Dr. ALEXIS A. JULIEN read a paper, by Dr. H. CARRINGTON BOLTON and himself, on

THE SINGING BEACH OF MANCHESTER, MASS.

The paper was illustrated by a series of specimens of beach sands, from many American and foreign localities, some with the

same sonorous property as that displayed on any disturbance or sudden pressure of the sands of the beach at Manchester, and others without it. The limited literature of the subject was discussed; the results of the microscopic examination of the sands given in detail; and a theory suggested in explanation of the peculiar sounds.

Dr. P. De P. Ricketts remarked on a specimen of sand in his possession, from the Desert of Sahara, which fell upon the deck of a ship fifty miles off the coast of Africa.

Dr. Julien then read a paper

ON A FORM OF GRAPHITE FOUND AT TICONDEROGA, N. Y.

(Abstract).

The presence of carbon, in amorphous form or in combination, in meteorites, its wide distribution through a certain band of the Archæan strata, and the further evidences of an enormous amount of deoxidation, can be explained, in the present state of our knowledge, only by reference to the life-force. The occurrence of organic structure, more or less perfectly preserved, in the Cambrian strata of Great Britain, the Cambrian and Huronian of Canada, the Huronian of Michigan, and many strata of Cambrian or Siluro-Cambrian age along the Appalachian belt, as far south as Georgia, corroborate in part this view. The distribution of graphite in the crystalline rocks of Canada, and the obscure fibrous structures therein detected by Dawson, were then discussed, and its more limited dissemination through the crystalline rocks within the boundaries of the United States. A description was then given of the graphite vein at Ticonderoga, N. Y., and of a bed of fine-grained white marble penetrated by graphite in slender blades, with fine longitudinal fibration, which suggested the similar form and structure of the leaves of a water-plant.

DISCUSSION.

The President remarked that the comparison, made by Dawson, of the amounts of carbonaceous matter in the Laurentian and coal formations can only be accepted as local. In either case, it is far exceeded by the amount of carbon now found in the bituminous shales, etc., of Devonian, Carboniferous, and later age.

Graphite must be of organic origin and derived mostly from plant life. It is true that limestones are often found saturated with carbon derived from animal remains, at least in some portion; since there are usually only traces of animal organisms, and the

presence of sulphur and nitrogen is an additional indication. Still these facts are not decisive, since sulphur and nitrogen occur also in plant tissue, and the soft material of seaweeds becomes so broken down by decay that its structure readily disappears. We cannot but believe that we must credit part of the carbon in some limestones to vegetable matter; and this may be true of the clouded marbles, presenting dark lines on a white ground, with wavy structure due to mechanical violence. Carbon often occurs in marbles as graphite, which is the residue from the distillation of hydrocarbons. Its quantity is sometimes small, but sometimes sufficient to color them even absolutely black. In metamorphism the carbon largely disappears, so that the graphite remaining may represent but a tenth part of that originally present. At Newport, R. I., films of carbon occur, converted into graphite, covering the impression of ferns, etc. Graphite is also capable of condensation and segregation, as illustrated by the graphitic carbon in cast iron, sometimes beautifully crystallized in cavities. Here it has been plainly derived from the carbon of the coal, *i. e.*, it is really of organic origin. So also in limestones beautiful crystallizations of carbon occur, the conditions having been favorable for its crystallization along with other crystallized minerals, *e. g.*, pargasite, tremolite, etc.; thus the purest of all graphites have been formed.

Dr. P. De P. Ricketts then made an exhibition of specimens, and spoke on the subject of

CERTAIN ORES FROM NORTH CAROLINA.

(Abstract.)

Dr. Ricketts first gave an account of a visit to Fisher Hill, near Greensboro, N. C.

The country rock there is crossed by veins of quartz, with dykes of dioryte.

Reference was also made to a visit to some mines in Montgomery County, where the gold is native to a much greater depth than in the case of the Fisher Hill veins, and occurs along the line of contact between a silicified slate and quartzyte, the latter forming what might be called the hanging wall of the vein. The gold occurs native in thin films in zinc blende, which is associated with galena, and iron and copper pyrites. The richest portion of the deposit is along the line of the hanging wall mentioned; but the seams are very thin and uncertain.

A visit to some copper deposits in Person and Granville Counties

was also described. The veins in this region were first opened during the past summer.

The Gillis mine is the only one with a history, having been reported upon by Prof. JACKSON at the close of the war.

The country rock is slate, which dips east, with a strike north 10° east. Dykes occur, and evidences of the metamorphism of the slates, which, along the line of contact, contain metallic copper. The dykes themselves are sometimes strongly impregnated with sulphuret of copper and metallic copper, averaging a content of two per cent., at one place visited, in metallic copper. Epidote is also largely found along the centre of the ridge, or line of contact.

The quartz veins in this region carry carbonate, silicate, and sulphuret of copper, and generally strike north 10° east. One vein, however, which Dr. RICKETTS inspected, about 2½ feet in width, crosses this direction at right angles, dipping to the north.

The first-class ore from this vein yields forty per cent. of copper and 25 ounces of silver to the ton. A large number of specimens from these veins were exhibited.

These remarks were briefly discussed by the President, Dr. RICKETTS, and others.

May 21, 1883.

LECTURE EVENING.

The President, Dr. J. S. NEWBERRY, in the Chair.

The large Hall was filled by the audience.

Prof. D. S. MARTIN read by title the two following papers: by Prof. EDWARD V. MARTENS, communicated by Mr. THOMAS BLAND,

DESCRIPTION OF TWO SPECIES OF LAND SHELLS FROM PORTO RICO—

Cistula consepta, *nov. sp.*

Chondropoma Tortolense—Pfr., *var.* major.

and by THOMAS BLAND,

DESCRIPTION OF TWO NEW SPECIES OF ZONITES FROM TENNESSEE—

Zonites Wheatleyi, *nov. sp.*

Zonites petrophilus, *nov. sp.*

Prof. JOHN K. REES, of the Observatory of Columbia College, New York City, then delivered the monthly lecture, on the subject of

THE GREAT TELESCOPES OF THE WORLD.

May 28, 1883.

The President, Dr. J. S. Newberry, in the Chair.

Thirty persons present.

The President exhibited specimens of coal plants, brought by Mr. Hague, from the northeastern part of China. These specimens were of Mesozoic age, like those of the Richmond basin. There is, however, a large development in the northern part of China of the true Carboniferous series, with anthracite, and including the remains of plants of that formation.

Prof. D. S. Martin then read a paper by Mr. Geo. N. Lawrence, entitled

DESCRIPTIONS OF NEW SPECIES OF BIRDS OF THE GENERA CHRYSOTIS, FORMICIVORA AND SPERMOPHILA

Chrysotis caniformis, *nov. sp.*, from the Island of Aruba, W. I.

Formicivora grivigula, *nov. sp.*, from British Guiana.

Spermophila parva, *nov. sp.*, from Mexico.

Dr. Alexis A. Julien read a paper entitled,

NOTES ON THE FLORA AND FAUNA OF THE ISLANDS OF CURAÇAO, BUEN AYRE, AND ARUBA, W. I.

This paper discussed in some detail the most characteristic features of the flora and fauna of these rarely visited islands, and concluded with the following contribution, by

Mr. Thomas Bland, entitled,

NOTES ON THE TERRESTRIAL MOLLUSKS WHICH INHABIT THE ISLANDS OF ARUBA, CURAÇAO, AND BUEN AYRE.

In 1882, my friend Dr. Alexis A. Julien, visited the islands above named, and collected a number of land shells, which he lately submitted to me for examination.

The following is a list of all the species known at this date to inhabit those islands.

It should be mentioned that the islands are at no great distance from the mainland of Venezuela, and within the 100 fathom line of soundings.

ARUBA.

* Tudora *megacheila*, Pot. & Mich.

* Bulimulus elongatus, Bolt.

CURAÇAO.

* Tudora *megacheila*, P. & M.

* Tudora *megacheila*, var. ?

* Cistula *Raveni*, Crosse.

* Succinea *gyrata*, Gibbons.

Bulimulus multilineatus, Say. Also New Granada, Venezuela and Florida.

* Bulimulus elongatus, Bolt. Also Porto Rico, Virgin Is., St. Croix, and several of the Lesser Antilles; also Central America.

* Cionella *Gloynei*, Gibbons, has dentition of the genus, W. G. Binney.

Geostilbia ? Sp. indet.

* Strophia *uva*, L. Gibbons found a young dead specimen at Sta. Martha, but supposed it to have been brought from Curaçao. Woodward and Paetel erroneously refer the species to Guadeloupe.

Pupa *longurio*, Crosse.

* Macroceramus inermis, Gundl. Also Cuba. I considered the Curaçao species to be *M. Gossei*, Pfr., which is found in Jamaica, Cuba, Bahamas and Florida. Dentition same as of *Gossei*, W. G. Binney.

* Cylindrella *Raveni*, Bland.

Stenogyra octonoides, C. B. Ad., Gibbons. Also Jamaica, Cuba, Bahamas, Hayti, and other of the West India islands.

BUEN AYRE.

* Tudora *megacheila*, P. & M.
* Tudora *versicolor*, Pfr.
* Tudora *versicolor*, ? var ?
* Cistula *maculata*, *nov. sp.*

I add the following description, which will serve to identify it. Shell, rimate, elongate, thin, finely striate, pale horn colored, with 4 to 6 spiral bands, on each whorl, of reddish-brown spots arranged in longitudinal lines; bands and spots sometimes more or less obsolete; suture deep, whorls, 7 to 8, convex;—the upper 3 whorls usually absent, the last descending, solute; aperture, circular; peristome, simple, slightly thickened. Operculum, closely fitting upon, scarcely extending beyond the margin of the peristome.

Length of the shell, entire, 10 mill; of remaining whorls, 8 mill, breadth of penultimate whorl, 4 mill; diameter of aperture, 2 mill.

* Succinea *gyrata*, Gibbons.
* Conulus ?—indet., one dead specimen found.
* Bulimulus elongatus, Bolt.
* Cionella *Gloynei*, Gibbons.
* Strophia *uva*, L.
* Macroceramus *inermis*, Gundl.
* Cylindrella *Raveni*, Bland.

The species, to the names of which an asterisk is prefixed were col-

lected by Dr. JULIEN. The species whose specific names are printed in italics, are peculiar to the islands named.

Helix pentodon, Mke., has been included in lists of Curaçao shells, but it is unquestionably a young *Strophia*, and probably of S. *uva*, L. PFEIFFER suggests (Mon. VIII) that it may be the young of S. *Milleri*, Pfr., found in the Bahamas.

It will readily be admitted, seeing the genera represented, that the fauna of the islands under consideration, is, as remarked by Gibbons with respect to Curaçao, by no means of the character one might expect from their geographical situation.

Tudora and *Cistula*, of the operculates, are alone represented. Of the former, nearly all the known species inhabit Jamaica, Cuba, and Hayti. The genus has no representative in the Lesser Antilles. The greater part of the species of *Cistula* are from Jamaica, Cuba, Hayti, and Porto Rico, in each of the islands of Sombrero, St. Croix, Antigua, and Trinidad there is one species.

The occurrence, in Curaçao and Buen Ayre, of *Strophia* and *Macroceramus*, is peculiarly interesting. Both genera are unrepresented in the Lesser Antilles. Nearly all the known species of *Strophia* inhabit the Bahamas and Cuba. In Hayti and Porto Rico are two, the same species—one in the Virgin Islands, one fossil, in St. Croix, and the impression of one is found in the phosphatic lime rocks of Sombrero.

Strophia is represented on the American continents, by one species only, in Florida and several of the adjacent Keys—a species which belongs to Cuba and the Bahamas.

With regard to *Macroceramus*, a large majority of the known species belong to Cuba and Hayti; to Jamaica, Porto Rico, and the Virgin Islands, 2; Bahamas and Turk Islands, 2; Anguilla, 1. There are four or five species in Florida, Mexico, and Central America.

Of *Cylindrella*, about three-fourths of the known species are found in Jamaica, Cuba, and Hayti. There are five or six species only in the Lesser Antilles.

I have thus conclusively shown that the land shell fauna of Aruba, Curaçao, and Buen Ayre has very marked alliance with the faunas, especially of Jamaica, Cuba, and Hayti; very little with that of the Lesser Antilles, in which *Tudora*, *Strophia*, and *Macroceramus* are wanting, and *Cistula* and *Cylindrella* have trifling representation.

The fauna of the three islands under special consideration has no appreciable connection with the adjacent continent, save, perhaps, as regards B. *multilineatus*.

Looking at the remarkable fauna of the the three islands, I may call attention to the interesting result of the soundings taken across the Caribbean Sea, in the winter of 1878–9, and reported to the Superin-

tendent of the Coast Survey, by Prof. Alex. Agassiz, in a letter which was published in the Bulletin of the Mus. of Comp. Zoology, vol. v., No. 14.

NOTE.—In Los Roques, not far to the eastward of Buen Ayre, a peculiar form was discovered, described by M. Crosse in 1873, as *Ravenia Blandi*,—allied to *Spiraxis*, but with a tooth on the outer lip.

The paper was discussed by Dr. B. N. MARTIN, Dr. WM. ORMISTON, and the PRESIDENT.

June 4, 1883.

BUSINESS MEETING.

The President, Dr. J. S. NEWBERRY, in the Chair.

Forty persons present.

Certain recommendations of the Council were adopted, and it was voted to adjourn the sessions of the Academy, as usual, for the summer. Notice was given by the President that when the meetings are resumed, at the beginning of October, they will be held in a Lecture-room of the new building of Columbia College, in East 49th street, where the Academy would be accommodated free of rent, according to the proposal made and accepted last spring.

Prof. D. S. MARTIN, the Chairman of the Publication Committee, was authorized to remove all the property of the Academy, now at No. 12 West 31st street, to a room provided without charge in the building of Columbia College.

It was "*Resolved*, that the Secretary of the Academy be empowered to act for the Academy in extending an invitation to the American Association for the Advancement of Science to hold its meeting of 1884 in New York city, and to communicate on the subject with the Permanent Secretary of the Association and with the other scientific societies of the city."

The resignation of Dr. RYLANCE was accepted.

The Publication Committee reported, through its Chairman, Prof. D. S. MARTIN, that Number 12, the closing part of Volume II. of the Annals, was in type, and nearly ready for issue and distribution.

Mr. GEORGE F. KUNZ exhibited a number of remarkable and interesting minerals, comprising a large set of fine zeolites from

several tunnels through the trap ridge of Bergen Hill, and other species from North Carolina.

Dr. J. S. NEWBERRY then read the following paper:

THE EVIDENCES OF ANCIENT GLACIATION IN NORTH AMERICA, AND THEIR BEARING ON THE THEORY OF AN ICE PERIOD.

(Abstract).

Prof. Newberry exhibited a map of North America, on which he had represented all the known glaciated areas, and described, chiefly from his own observations, such as lie within the limits of the United States. He showed from the facts given, first, that glaciers once covered most of the elevated portions of the mountain belts in the Far West, as far south as the 36th and, in the eastern half of the Continent, the 40th parallels; second, that the ancient glaciers were not phenomena produced by local causes, but were evidences of a general climatic condition; third, that they could not have been produced by a warm climate and an abundant precipitation of moisture; fourth, that they were the products of a general depression of temperature, and therefore were proofs of the truth of the glacial theory. The facts presented may be briefly summarized as follows.

The glaciation of the Sierra Nevada is general and very striking; it has been described by Whitney, King, Le Conte, and others, who have given abundant proof that all the highest portion of the range was once covered with snow-fields, and that glaciers descended from these down the valleys on either side.

Mt. Shasta once bore many great glaciers, of which miniature representatives still remain.

The Cascade Mountains exhibit perhaps the most stupendous record of ice-action known. All the higher portions of the range are planed down and furrowed by glaciers, which descended into the valley of the Des Chutes on the east, and that of the Willamette on the west, as shown by the observations of the speaker in 1855, at least 2,500 feet below the present snow-line. Mt. Ranier still carries glaciers of considerable size; and all the country around, as well as about Puget's Sound and on Vancouver's Island, shows evidence of former glaciation In British Columbia the signs of ancient glacial action, as shown by George M. Dawson, Dr. Hector, Richardson, etc., are conspicuous in all the high country explored. The valleys of the Wasatch range were once filled with masses of ice as far south as central Utah. A type of these was the Little Cottonwood glacier of which the record has been carefully studied by Dr. Newberry. It formed in a cirque at Alta, 10,000 to 11,000 feet above the sea, had a length of about ten miles, a thickness—as shown by the line of granitic blocks left along its sides—

of 500 feet or more, and its lower end was only 5,500 feet above the sea.

The glaciation of the Uinta range has been graphically described by King, who says that the ancient glaciers of these mountains occupied a greater area than all those of the Alps.

In the Rocky Mountain belt the signs of glaciers abound, from the northern part of New Mexico through Colorado, and along the great divide in Wyoming, Montana and Idaho.

In these Western mountain ranges the glaciers were far more extensive than any now to be found on the earth's surface, unless on the Antarctic continent or Greenland. The record they have left consists of planed, grooved and striated rocks, covering immense areas, lateral and terminal moraines, moraine lakes, etc., etc.,—a record which is as legible and reliable as any printed page.

In the country east of the Mississippi, the evidence of ancient glaciation is even more widespread and impressive than in the Far West. All the surface rocks of Canada, of New England, of New York, and the greater part of Ohio, Indiana, Illinois and Wisconsin, bear marks of ice-action, and are generally covered with a sheet of drift material which has been carried by glaciers from the north southward, often many hundred miles. This glaciated and drift-covered area extends from Maine and Massachusetts westward in a belt parallel with the arch of the Canadian Highlands, 500 miles wide and more than 2,000 miles long. Its extension northward from the head-waters of the Mississippi has not been traced further than Lake Winnipeg, where it was studied by Hind; but there are good reasons for believing that it extends to the Arctic Ocean, and that the great lakes of the North, like those of the St. Lawrence chain (Superior, Huron, Michigan, etc.), are old river-valleys scooped out and modified by glaciers. Above the Canadian line, George M. Dawson reports that the glacial drift from the Canadian Highlands extends westward till it meets that which was spread eastward from the Rocky Mountain belt.

From the facts already gathered, it is a justifiable inference that fully one-half of the continent of North America, north of the 36th parallel, was at one time covered with ice or perpetual snow, and, so far as we can now judge, the glaciation of all the areas enumerated was synchronous, and that it occurred at the same time with the great expansion of the glaciers of Europe.

Some writers have attempted to prove that a large part of the glacial phenomena described are really the work of icebergs, and the consequences of a great continental subsidence; but no man who has studied the inscriptions made by glaciers will hold to such a theory, when he has traversed much of the glaciated areas east or west of the Mississippi.

While the phenomena described above are unmistakable, and constitute an indisputable record of the prevalence of ice-sheets over great areas of our continent, much speculation has been lavished upon the possible causes of such accumulations of ice and snow as have here left their marks. In a voluminous and elaborate review of the subject recently published by Prof. J. D. Whitney, the glacial record is misrepresented and belittled. By this author it is stated that ice has little or no eroding power, while every one who has traveled through the glaciated areas has noticed the peculiar impress left upon the topography by the old glaciers ; and the sheet of drift material now remaining, as the result of ice-erosion,—over one area, 2,000 miles long and 500 miles wide, from 30 to 50 feet thick—is in itself a sufficient answer to this assertion.

But our drift deposits are only a remnant of the mass of material eroded by the glaciers. Most of the flour they ground—the clay—has been washed away, and, over great areas, only the bran—gravel, sand and boulders—remains. All the streams flowing from glaciers are turbid with sediment supplied by the grinding of rocks by ice. This has been measured in some cases, and the erosive power of glaciers has then been not only demonstrated but quantitatively determined; for example, the daily transport of sediment from the Aar glaciers in August is 280 tons, and Helland states that 69,000 cubic meters of solid rock are annually worn away by the Justedal glacier of Norway (Geikie) ; and yet we are told that ice has little or no eroding power !

By Professor WHITNEY the few glaciers, of which the record cannot be ignored or sophisticated, are considered as the product of local causes, and not as evidence of an *ice period*, which it is the great object of his book to disprove. The immense extent, however, of the glaciated area, reaching as it does, from the Atlantic to the Pacific, from the 36th parallel northward on high lands, and the 40th on low lands, as well as the evidence of approximate or exact synchronism in the phenomena, make it impossible to accept the theory of local causes.

We are in fact driven to the necessity of referring the record to a general climatic condition. What this condition was, is the next point for investigation ; its cause or causes still another. Professor WHITNEY, following LECOQ and others, claims that since snow and ice are moisture evaporated elsewhere by heat, the extension of glaciers at any time or place is simply an effect of increased heat and not cold ; and hence if there ever was an ice period—meaning a time when glaciers were more widespread than now—it must have been a warmer period than the present, with more copious precipitation. Only a few of many facts need be cited to show that this theory is untenable. First, glaciers are now confined to altitudes and latitudes, where the temperature is low—

Alpine summits and the Arctic and Antarctic continents. To widen and intensify the conditions which now produce glaciers would necessarily induce an extension of snow and ice. Second, on the Cascade mountains we find a copious precipitation of rain and snow, but no ice, where great glaciers formerly existed. The snow-line is 7,000 feet above the ocean; and there the temperature is high enough to permit the most vigorous growth of trees and smaller plants. The fir forests here meet the snow-banks in actual mechanical conflict, and the front ranks of trees, though of good size, are weighed down by the snow, and grow prone and interlaced upon the ground.

The snow-fields rise 3,000 to 4,000 feet above the snow-line, and there are miniature glaciers at the heads of the valleys—relics of the great glaciers that once filled these valleys to their mouths. The precipitation remains, the snow fall remains, but the glaciers are gone!

Here we have just the conditions most favorable to the formation of glaciers, according to the theory of those who regard them as *thermal phenomena*, but no glaciers, *because of the high annual temperature.* With a depression of temperature, which should cause the rain-bearing winds from the Pacific to do all the year what they now do only in winter, viz., heap up snow on the highlands, the mountain slopes and draining valleys would soon be occupied by glaciers again. So if winter conditions could be made permanent on the great water-shed of the Canadian Highlands, and the flow of the St. Lawrence, Mississippi and Red River be retained in the form of snow and ice, glaciers would soon fill again the lake basins, over-ride the highest summits, and cover with an ice-sheet all the old glaciated areas. Even if the evaporation from adjacent seas was somewhat diminished by the cold, that would not change the result, though it would prolong the time. If the evaporation in the region surrounding the North and South poles is, as we have demonstrative evidence, sufficient to produce continental glaciers on Greenland and the Antarctic continent, it requires no argument to show that like conditions would produce like results in what is now the temperate zone.

The relations which the ancient great lakes of the Far West bore to the former glaciation of the same region is an interesting subject of inquiry. It has been suggested that it is the relation of cause and effect, but this seems hardly possible. They may have been synchronous, and to some extent co-operative phenomena, but the relationship was rather fraternal than filial. The cause of the former great breadth of water-surface was either an increased precipitation or a diminished evaporation. We not only have no record of any change in the relationship of the North American continent to the Pacific, in modern times geologically speaking, but the evidence against any change is conclusive.

Everything indicates that the system of rain-bearing winds, the topography, and hence the precipitation have been substantially the same for a long period. But any cause which could produce a depression of temperature would certainly diminish evaporation, and form lakes in the valleys and glaciers on the mountains. To prove this, we have only to cite the phenomena presented by summer and winter in the western territories. In winter, the snow-fall on the highlands is heavy, and the accumulation of moisture in this form is large. The skies are cloudy, and evaporation is small. In summer, the sky is cloudless, the heat intense, evaporation and desiccation rapid. In the spring the snows melt, flood the valleys and form temporary lakes, which in midsummer dry up to *playas*. A perpetuation of the conditions of winter and spring would inevitably produce glaciers and lakes, and these would be essentially synchronous. A depression of temperature, which should intensify and prolong the present winter, and make midsummer like the present May, would inevitably produce glaciers and lakes, in the main synchronous, and thus would accomplish all that we find recorded. But to intensify and prolong summer by an elevation of temperature, would not produce either lakes or glaciers.

That the ice period was cold and not warm, is further proved by the prevalence of an Arctic flora and fauna on the land and in the sea, in all regions near the old glaciers. The Arctic shells of the Champlain, the Arctic plants in the Quatenary clays, the reindeer, musk ox, woolly mammoth and woolly rhinoceros, all tell the same undeniable story.

From the facts cited, and others of similar import in the southern and northern hemispheres, we must conclude, 1st, that a glacial period has prevailed simultaneously or alternately in both hemispheres; and 2d, that the glacial period or periods were periods of lower temperature than that of the present day.

An inquiry into the *cause* of the cold of the ice period would open a question beyond the scope of this paper, and one too broad and suggestive to be discussed to any purpose in the time at our command. I may say, however, in passing, that I have elsewhere shown that no arrangement of land and sea, consistent with the known facts of Tertiary and Quaternary history, will enable us to refer that cold to any topographical or even telluric cause. Some extraneous influence, such as a variation in the heat radiated by the sun, as suggested by NEWCOMB, or a variation in the eccentricity of the earth's orbit, as advocated by CROLL, or some other cosmical cause, must be credited with effects so widespread and stupendous as the ice period has left behind it.

The Academy then adjourned to meet October 1 in the new building of Columbia College, at Forty-ninth street and Madison avenue.

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OF THE

NEW YORK ACADEMY OF SCIENCES.

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TRANSACTIONS

OF THE

New York Academy of Sciences.

October 1, 1883.

REGULAR BUSINESS MEETING.

The President, Dr. J. S. NEWBERRY, in the Chair.

Twenty-four persons present.

The resignation of Prof. T. EGLESTON as member of the Council was received, and Prof. H. L. FAIRCHILD was elected in his place.

Dr. NEWBERRY spoke on the subject of his travels and observations in the West during the past summer.

Prof. D. S. MARTIN referred to a visit recently made to Trenton, to examine the stone implements found by Dr. CHARLES C. ABBOTT in the Glacial gravels in the vicinity of that city. On his motion, Dr. CHARLES C. ABBOTT was then elected a Corresponding Member of the Academy.

Prof. MARTIN then read, by title and abstract, a paper, by Prof. THOS. EGLESTON, on

THE PATIO AND CAZO PROCESSES FOR THE AMALGAMATION OF SILVER ORES, USED IN MEXICO AND CHILI.

(Printed in the Annals, Nos. 1 and 2, Vol. III.)

Dr. B. N. MARTIN exhibited a specimen of crystallized chloride of silver from Canada.

Dr. N. L. BRITTON exhibited specimens of zeolites, associated with native copper, and of sulphide of copper from the Isle Royale Mine near Houghton, Mich., and a large and regular pseudomorph in chlorite after dodecahedral garnet.

The PRESIDENT remarked that the Isle Royale Mine was the second locality in the Lake Superior region at which the copper sulphide has yet been found. The carbonate and silicate of copper occurred there only in crusts, while the native silver and copper, whose abundance is well known, are precipitates from chemical solution by electrolysis.

Prof. MARTIN mentioned the recent death, at Hamburg, of Dr. THEODORE H. TELLKAMPF, a member of the Academy, and referred to his valuable studies and papers on the ascidians of our coast.

Mr. A. R. CONKLING briefly explained the Patio and Cazo processes for amalgamating silver ores.

The PRESIDENT suggested that the costly mills and stamps, now used for reducing silver ores, must give way largely to simpler and cheaper machinery and methods employed in the leaching process.

October 8, 1883.

SECTION OF PHYSICS.

The President, Dr. J. S. NEWBERRY, in the Chair.

Sixty-five persons present.

Mr. B. B. CHAMBERLIN exhibited a specimen of graphite from a boulder found on the bluff at Weehawken, the first discovered in the vicinity of this city, and probably derived from the outcrop at Bloomingdale, N. J.,—also specimens of graphite from Hull, Canada; Mr. G. F. KUNZ, a curious specimen of capped or penetrated beryl, in which a pyramidal crystal of that mineral was enclosed within another of the common hexagonal form, from the topaz locality at Stoneham, Me.; and the PRESIDENT, a specimen of native lead from the Wood River region of Idaho, the mineral occurring in the upper portions of the veins, associated with red oxide of lead, and solid unchanged galena, in masses of quite unprecedented size.

The recent death of a Resident Member, Mr. H. G. CHAPMAN, was announced, and also, in last August, of Mr. EDWARD PRIME of Riverdale, one of the early members and a subscriber to the original building fund.

A paper was then presented by Prof. WILLIAM P. TROWBRIDGE, illustrated by diagrams, on

TORNADOES.

DISCUSSION.

Dr. A. A. JULIEN recalled the careful observations and hypotheses of Redfield and Espy, according to which the initiation of a tornado depended upon the ascent of a rarified column of heated air. The subsequent conflict of opposing currents, and the continuance and development of the central area of diminished barometrical pressure, seemed to be, however, but the secondary phases of the phenomenon. In illustration he described a similar class of facts observed in the birthplace of the hurricanes of the tropics—the great marine plain of the Caribbean Sea—during the "hurricane season," from July to September of every year. There, as over the Western plains of our continent, the atmosphere becomes strongly heated by the fervid rays of the sun, quivering with ascending currents over the broad sheets of naked and white coral limestone which forms the plateaus or rims of many islands. Over the sea, heaped up and swelling cloud masses of cumuli mark here and there the ascent of a strong aërial current, and at times numerous waterspouts project toward or down to the sea in all stages of formation. Of these he had observed one or two dozen, visible at the same time, while residing on the Key of Sombrero, and also while voyaging through the Mona Passage. On one occasion a waterspout approached the precipitous eastern cliff of Sombrero, within a distance of five hundred feet, before it suddenly broke and disappeared.

Even on the land the same ascensional tendency is frequently shown by the passage of whirling dust columns, catching up sand and light objects in a funnel-shaped, whirling shell, sometimes fifty to a hundred feet in height. So gentle is the breeze in which these whirling columns are developed that they move quite slowly along the level surface of the ground. A person can manage to walk at an ordinary pace within the centre of the whirling current, and can distinctly exhibit its tangential velocity and the form of the whirling shell by suddenly throwing into it a quantity of fragments of paper or similar light material. All these phenomena are produced in a still atmosphere, or among very gentle breezes from easterly points; but it is important to note that the rising of the wind, especially from opposite points, occurs rarely at such a season, and seems to indicate the second stage of atmospheric disturbance—the beginning of a hurricane or cyclone.

Mr. H. L. WARNER inquired as to the cause and mode of origin of the extreme ascensional velocity at the centre of the tornado, and of its enormous lifting power and circular motion, since he could not un-

derstand how the force at the centre could exceed the pressure of a vacuum.

Prof. W. P. TROWBRIDGE replied that in a cyclone the motion, which in the Northern Hemisphere proceeds from right to left, comes from the motion of the earth. In whatever direction a body may be moving along the surface of the earth, a tendency to deflect it to the right is caused by the earth's motion. Aërial currents flowing toward a central point thus become deflected, and a rotary motion ensues. In a cyclone, therefore, the currents of heated air rushing from opposite directions result in an ascending current, surrounded by a rotating column, both of extreme velocity.

The PRESIDENT remarked that he had been much in the arid regions of the West, as in Arizona and Nevada, where the sun's rays produce intense heat, with violent currents of wind and numerous eddies or "whirlwinds." This action was often observed in running water, as shown by the whirlpools, which possess far higher velocity than that of the main eddy. So in this arid region frequent contrasts of currents of air occurred, generating at the points of junction local whirlpools of great velocity.

He regarded the statistics that had been published, in relation to the occurrence and number of tornadoes, as likely to mislead. The atmospheric conditions were much alike in most of the States of the Mississippi valley, and it is probable that if observations on the occurrence of tornadoes should be carried on for a long time, perhaps for some centuries, closely agreeing results would be obtained.

He described the phenomena of a tornado in Ohio in 1847, by which not only fences and houses were destroyed, but half-buried logs were torn up out of the ground, a plow carried along by the wind left a spiral furrow, and chickens were almost completely stripped of their feathers.

In the forest-covered region east of the Mississippi, winds are more obstructed and less violent, and tornadoes are probably less common than on the prairies, but are not unknown. Many have been recorded since the country was occupied by the whites, and many more are self-registered in the tracks they have left in the forest. These tracks are known as *windfalls*, and every woodsman is familiar with them. They are passes opened by whirlwinds, which, for a longer or shorter distance, and greater or less breadth, have prostrated or twisted off the trees. In Ohio and Michigan hardly a township is without them, some recent and some very old, for such a record would hardly be obliterated in a hundred years. Their number proves the frequency of the occurrence of wind-storms, and that no part of the country was exempt from them. As the number of towns, villages, and farmhouses increases, storms attract more attention, as they cause destruction of

property and loss of life ; but we have no reason to suppose they are more frequent now than formerly, and they are liable to occur in all parts of the United States. If the early settlers of the forest-clad region had made notes of the windfalls they had observed, we should have a more interesting meteorological record, and one which would add much to our knowledge of the distribution of these fearful phenomena.

October 15, 1883.

SECTION OF GEOLOGY.

The President, Dr. J. S. NEWBERRY, in the Chair.

Thirty-four persons present.

Prof. O. P. HUBBARD stated that he was one of a large party of business men, chemical experts, and the Chinese Legation at Washington—invited on the 10th inst., by the Rio Grande Sugar Company, to visit their plantation and refinery, situated about five miles north of Cape May, N. J.

The region is of a light sandy soil, of which there is an immense area in East New Jersey and the sea coast of Delaware and Maryland. The plantation contains 3,000 acres, and 73 were in crop of the Early Orange and Amber varieties of Sorghum, which, notwithstanding a long drought, seemed well developed and matured. All the processes of the manufacture, with improved machinery, were in active operation—from the entering of the cane to the rollers, defecation of the juice, and boiling the syrup in open and vacuum pans, to the crystallization and separation of the sugar by the centrifugal process into a yellow and a white variety, ready for market. The State of New Jersey wisely aids this important industry by a bounty of $1.00 a ton on Sorghum thus raised, and one cent a pound on all sugar manufactured from it.

Prof. HUBBARD exhibited several heads of the seed of the Early Orange and Amber varieties of Sorghum, and specimens of crystallized white and yellow cane sugar, manufactured from the plants raised by this Company.

Mr. A. H. ELLIOTT referred to the mode of development of the beet sugar industry in Europe. In England, the product of sugar, obtained from the sugar-beet, had been raised to seventeen or eighteen per cent. Half of the sugar of the world is now derived from this source, and the earlier stages of its introduction

resembled very much those which now attend the development of the Sorghum industry.

The Vice-President, Dr. B. N. MARTIN, remarked on the introduction of the sugar-beet, many years ago, into Massachusetts, by means of seed imported from France. The plant thrived, and the root was rich in sugar; but the industry met with an insuperable difficulty in the fact that the farmer found the product more valuable for feeding stock.

The PRESIDENT stated that he had seen thousands of acres of Sorghum, in Missouri, Kansas, etc., and that we hardly realized the importance of this industry in many parts of the country west of the Mississippi. The cane was liable there to be overtaken by untimely frost, by which the profits of the crop were often lost. The crop there has been thus injured this year to such an extent, that in many places only syrup can be made from the canes. Sorghum can be successfully cultivated in all the Middle States by a proper mode of planting and choice of varieties. Its product, for a long time, consisted only of a syrup which had a peculiar flavor, earthy, raw, and offensive at first; but this has been since removed by improved processes, though the mode of manufacture is somewhat complicated.

Mrs. E. A. SMITH exhibited a series of interesting specimens of siliceous sinter and of silicified wood from the Yellowstone region. In regard to these, the PRESIDENT explained that similar specimens of silicified wood were abundantly found in the Bad Lands. Their geological position is in the Tertiary and near the top of the Cretaceous formation. They are generally of coniferous wood, and represent trees similar to the gigantic Sequoias of California, which, in the Tertiary and Cretaceous ages, formed forests which contained many splendid forms of arborescent vegetation, now extinct, as well as the finest of our living forest trees, and covered all the continent to the Arctic Sea. Floated down the ancient rivers of the country, and buried in the silt which accumulated in the bottom of great lakes which once existed there, they were subsequently replaced by silica, particle by particle, so that the structure is often perfectly preserved. In Yellowstone Park is a veritable petrified forest of such trees, successive generations of which were buried under volcanic ashes and mud, like that which covers Pompeii, and were in part silicified standing.

The specimens of the deposits of the geysers and hot springs of the Park, exhibited by Mrs. SMITH, are of two kinds; one, silicious (geyserite), from the geysers; the other, calcareous, from the "Mammoth Hot Springs." The first kind was produced by the action of hot water on a silicious volcanic rock (rhyolyte); the second, on limestone, which underlies the northwest corner of the Park. A third kind of deposit is seen in the "paint pots" and "mud geyser" of the Norris basin, a pink or white clay, apparently derived from the feldspathic portion of the decomposed rhyolyte, the quartz having been dissolved out. The clay in the paint pots is sometimes highly colored, forming a pasty or semi-fluid mass in a state of constant ebullition from escaping steam. The deposit of calcareous tufa, from the Mammoth Hot Springs, is quite rapid, coating objects, like the horse shoes and other things shown, with a film an eighth of an inch thick, when they are immersed in the water for two or three days.

The PRESIDENT exhibited specimens of brilliant anthracite, sent by Mr. M. C. READ, Corresponding Member of the Academy, residing at Hudson, Ohio. They are reported to come from Hastings Co., Canada, a region underlain by Laurentian rocks. If this report is correct, they are probably the residue of the spontaneous distillations of petroleum, like the asphaltic anthracite of the Calciferous sandrock of Herkimer, in New York, and of the Utica shale at Canajoharie.

Mrs. JAMES WELD exhibited some peculiar crystals of carbonate of lime from Fort Laramie, Wyoming Ter.; hexagonal prisms, 1 to 2 inches wide, $\frac{1}{4}$ to $\frac{1}{2}$ inch in length, with bevelled edges; the form of aragonite, with minute and partial internal rhombic cleavage of calc-spar—probably aragonite changing to calcite.

Mr. N. H. DARTON read a paper

ON THE STRATA OF INDURATED SHALES BETWEEN BERGEN HILL AND THE PALISADES, N. J.

Prof. DANIEL S. MARTIN then spoke on the subject of

THE TRENTON (N. J.) GRAVELS, AND THEIR CONTAINED IMPLEMENTS, AS BEARING ON THE ANTIQUITY OF MAN.

(*Abstract.*)

After reviewing the general facts regarding prehistoric archæology abroad, as to the differences between palæolithic and neolithic imple-

ments, the speaker passed to the study of similar objects in this country, with special reference to the discoveries of Dr. C. C. ABBOTT in the river gravels at Trenton, N. J. During the past summer, the speaker had visited the localities near Trenton, and had conference with Dr. ABBOTT on the whole subject of his studies thereabout. (A black-board map was here employed to show the position and limits of the "river gravel" along that part of the Delaware Valley, in distinction from the earlier "yellow gravel," probably marine Tertiary, which covers much of the region of Southern New Jersey.)

Dr. ABBOTT had long been interested in gathering the Indian relics (neolithic and modern), which are found in great abundance on and near the surface of the country all about Trenton. Some years since, after reading the works of Sir JOHN LUBBOCK, he began to pursue the study more systematically and with growing enthusiasm, having entered into correspondence with Sir JOHN LUBBOCK, and sent him from time to time specimens of the implements, to the number of many hundreds. In this correspondence and study, it soon became apparent to both gentlemen, that a marked difference existed among the specimens. The majority of them were of the ordinary "Indian arrow-head" type, fairly wrought from flint, hornstone, or quartz; but a few were found of much ruder shaping, and made of a dark, compact argillite. Careful search and comparison soon revealed the fact of a corresponding difference in the mode of occurrence of these two forms, the ordinary ones being found on or near the surface, in ploughed fields, etc., while the rough argillite specimens were obtained only at a few points along the immediate river bank, and had, to all appearance, fallen or been washed out of the gravel bluff, which is some 30 to 50 feet high. Upon this, Dr. ABBOTT made his first published announcements of the discovery of remote pre-Indian relics in the river gravels, and connected those beds with the floods derived from the melting ice of the Glacial period.

So important a claim, naturally, was not suffered to pass unchallenged. The objection was raised at once, that proof was lacking of the actual occurrence of these implements in the gravels proper,—that they might have been washed down from the surface. The next stage of the investigation, therefore, was to search for the implements *in situ;* and it was not long ere they were successfully discovered, imbedded in, or projecting from, the gravel-bank, at depths of several feet below the present surface of the country. About this time, the Pennsylvania Railroad Co. began excavating and cutting away the gravel-beds at several points near Trenton, thus exposing large and fresh sections of perfectly undisturbed material, and affording greatly increased facilities for exploration. Dr. ABBOTT was not slow to im-

prove the opportunities thus brought, as it were, to his very door; and he soon began to find implements in these railroad cuttings, of the same style of material and of workmanship as those previously found in the river bluffs. There was now no possible doubt as to the important fact that rude palæolithic implements are truly contained in, and throughout, this dark stratified gravel of the Delaware valley, and that they furnish probably the earliest traces of man in eastern North America.

The most interesting part of the problem, however, yet remained to be solved. Of the facts there was no question. Implements of peculiar type, large, rude, and wrought from a hard, compact argillite, are characteristic of, and confined to, this gravel. The gravel bears the clearest evidence of its deposition from flowing water, the cross-bedding, etc., being frequently very finely displayed; and its well-rounded stones and pebbles have the flattened form distinctive of river wear, and are derived from the rocks higher up the Delaware valley. But when was this deposit formed, and what relation does it bear to the geology of the region?

It was impossible not to connect these palæolithic gravel-beds with the great Ice age; and Dr. ABBOTT, as above stated, had already done so, judging the deposit to date from the vast flood of cold water that poured through the valley of the Delaware during the time of the melting of the ice-sheet of the true Glacial period. Of course, this carried back the human occupancy of the country to a very remote antiquity.

At this stage of the investigation, a somewhat related, but wholly independent, series of observations was begun and carried on by Prof. H. CARVILL LEWIS, of Germantown, Penn., in connection with the Geological Survey of that State. Dr. ABBOTT'S work had been properly archæological, and chiefly confined to the local deposits at and near Trenton. Prof. LEWIS, on the other hand, took up a line of observation strictly geological, and ranging over a wider field, in the study of the surface-deposits of Eastern Pennsylvania. It now appears that facts have been developed in this way that could not have been gained from the Trenton region alone; and thus these two accomplished workers have supplemented each other's results, and conclusions have been reached which rest on independent, yet concurrent, evidence.

In the Old World, the distinction has long been familiar to students of ancient glacial phenomena, between an earlier and a later Ice-period, —the first, a great continental prevalence of arctic conditions, with a general movement of the ice-sheet southward; and the second, a less extreme and extended development of cold, showing itself, however, in local glaciation, in which all highlands and mountains became cen-

tres of glacial action. These two periods are distinctly separated by a milder "Interglacial" epoch. But this twofold character has not been so clearly recognized on this side of the Atlantic, although some evidences of it have been coming to view of late. Among the most interesting features of the study of the Delaware valley, is the clear and satisfactory indication that it has now given of the distinct existence of the two Ice-periods, here as well as abroad.

There was nothing at Trenton to show this fact. The gravels there were plainly of Glacial age, as above stated ; and that was all. But on studying the deposits of the Delaware valley lower down, near Philadelphia, the important fact comes to view that the continuation of the Trenton gravel there rests upon, and is distinct from, a series of deposits which are unmistakably those from the melting of the great ice-sheet. To Professor LEWIS is due this most interesting discovery. He has given the names of the "Philadelphia Red Gravel," and the "Philadelphia Brick-clay," to the two members into which these lower ("Champlain") deposits are divided, and has described their characteristics quite fully and clearly. Over these, and evidently later, is the dark-colored Trenton gravel, more fully developed higher up the valley, and containing these earliest human implements.

It appears, then, that we have at Trenton a deposit, ancient indeed, but not so far back in time as was at first supposed. The presence of man during the second Glacial period in Europe is abundantly familiar ; and the earliest remains there found certainly take us back to the preceding Interglacial time. The relics found in the Delaware gravels, therefore, are not so ancient as those of the earlier Palæolithic of the Old World, but correspond seemingly with those of the "Reindeer Epoch," a period of cold climate, in which the animals now withdrawn to the Alpine heights and the Northern latitudes, ranged over Central Europe, and when man lived and hunted and fished in a sub-arctic life, much as the Eskimo people do to-day. Prof. LEWIS has, therefore, suggested the name "Eskimo Period," as a designation for this time. He is disposed to think that the rude people who wrought and used these argillite implements by the banks of the icy-flooded Delaware were near of kin to the present occupants of Arctic America. This view, it may be added, gains interest and force from the indications gathered from the early Northmen's recorded visits to the New England coast, at which time it would seem that the natives whom they encountered were not the Indian tribes, but a people similar to the Eskimos,—a race which had completely disappeared in the four or five centuries that passed before the English discoveries and settlements. At any rate, however, we may accept the term Eskimo period as hap-

pily and justly applied to the second Glacial epoch on this continent, now clearly distinguished.

The paper was illustrated with specimens showing implements of both types from the locality referred to.

DISCUSSION.

In reply to inquiries by the PRESIDENT and Prof. FAIRCHILD, Prof. MARTIN stated that all the stone implements now discovered are added to the main collection at Cambridge, Mass.; but nevertheless Dr. ABBOTT possesses a considerable number, many of which present well-defined forms.

The PRESIDENT expressed great satisfaction with the clear account of this interesting locality given by Prof. MARTIN. There would seem to be no doubt of the genuineness of Dr. ABBOTT'S discoveries. Rude flint implements had certainly been found by him in the Trenton gravels, but these were postglacial in date, or at least formed by the drainage of the glaciers in their retreat, and hence not older than the river gravels of Europe which contained the oldest remains of man yet discovered there. The interval between the date of deposition of these gravels and the present time could not yet be expressed clearly, but it must have covered many thousands of years. This view would be repugnant to some who held to the conventional six thousand years which have been generally supposed to include all the time of Man's residence on the earth, but no one's faith need be disturbed by it. The chronology of the Mosaic record has always been a matter of discussion and difference among scholars and theologians, over two hundred different estimates having been put on record on this subject. The Rev. ADAM SEDGWICK, a distinguished divine and geologist of England, whose authority is, perhaps, second to none, summed up his discussion of this question by saying that in regard to the dates of the Creation of the world, and the appearance of Man on the earth, the Creator had in His wisdom left us without exact information, that no clear and positive statement was made on this subject in the Scriptures, and there has always been a wide and irreconcilable diversity of opinion as to the dates of the Book of Genesis among biblical scholars.

Dr. B. N. MARTIN referred to the many proofs of Dr. ABBOTT'S discovery in the large collections he had made of the worked flints, amounting to hundreds. Since their deposit at Cambridge, they had been examined and their character confirmed by so careful an observer as Prof. LUBBOCK. Prof. H. C. LEWIS and others had also gone over the ground with Dr. ABBOTT, discovered the implements independently for themselves, and verified their distribution as exactly corresponding with the area of the Trenton gravel. His own visit to the lo-

cality, in company with his son and Dr. ABBOTT, had been exceedingly interesting, including the examination of the exact points of occurrence of the worked flints at different depths of the gravel-bank, as well as of modern Indian implements at many points over the surface, but never imbedded in the gravel. He expressed his own very clear and decided impressions as to the care and fulness of Dr. ABBOTT'S researches, and the substantial accuracy of his results.

In reply to an inquiry of Mrs. E. A. SMITH, Dr. MARTIN further stated that the objections of Prof. BOYD DAWKINS related to the original and incorrect views of Dr. ABBOTT, who had been misled by Prof. G. H. COOK'S estimate of the geological age of this gravel deposit. Dr. ABBOTT also believed he had made an important discovery in a specimen of human tooth, which he had struck with his cane out of a gravel bank, and whose rolled, water-worn condition indicated a vastly greater age.

The PRESIDENT stated that Prof. DAWKINS had never visited the locality, and had not expressed to himself any positive opinion. It was an interesting fact that, in DAWKINS' classification of the early races of men, he calls the first race the River Gravel Men, afterward followed by the Cave-dwellers.

October 22, 1883.

The President, Dr. J. S. NEWBERRY, in the Chair.

Twenty-nine persons present.

The Chairman of the Publication Committee, Prof. D. S. MARTIN, reported that number 13, with the Index and Contents of Vol. II., of the Annals, was now ready for issue.

Mr. G. F. KUNZ exhibited a supposed emerald from Gibsonville, Guilford County, N. C. Mr. Smith, a farmer, while ploughing on his farm in March last, turned up an irregular shaped, smooth-faced stone, the size of a hen's egg. It glittered in the sunlight. Mr. Smith took the stone to Greensboro, where a jeweller pronounced it a genuine emerald weighing nine ounces. The jeweller was also of the opinion that smaller brilliants clinging to the central stone were diamonds.

The fact was published and aroused the greatest interest among jewellers and mineralogists. A diamond miner visited Mr. Smith and offered him $1,000 for the gem. Mr. Smith refused the offer, being assured that the emerald was the second largest in the world and of immense value. He brought it on to New York and intrusted it to a banker, by whom it was ultimately submitted to Mr. KUNZ for examination. After subjecting the stone to various tests, he found it to be a crystal of quartz, penetrated by long, hair-like crystals of green acti-

nolite or byssolite, and containing glittering rows of small cavities filled with liquid. It was only valuable as a mineralogical specimen for cabinet purposes, and was worth for such use about $5.

Mr. KUNZ also reported on the "Georgia Marvel," or the "Blue Ridge Sapphire," as it is called, which was found a little over a year ago in a brook in that State. The stone weighed about half an ounce, and was supposed to be worth about $50,000. Its discovery created even more interest than did that of the North Carolina emerald. Two well-known Southern jewellers asserted that it was genuine, and it was sent here for a crucial test. Mr. KUNZ said that after a short examination he found it to be a piece of blue bottle-glass, which had been rolled in the brook until the action of the water and gravel had polished it to unusual brilliancy; and he was obliged to glaze or enamel a piece of platinum wire with a fragment of the "sapphire" to convince the owner that it was glass.

He also exhibited fine crystals of limpid topaz, from Pike's Peak, Colorado, said to have been found in association with the amazon-stone and phenakite of that locality.

Dr. NEWBERRY exhibited and gave some description of a large collection of typical fossil fishes and leaves gathered by Mr. WILSON from the Central Rocky Mountains, at a locality about seventy miles north of the Union Pacific Railway, near Green River, Colorado. With these were associated a few fossil plants, including a fan palm, and many insects. They occurred in a fresh-water shaly limestone of Eocene age, occupying a part of the Green River basin, the whole formation being 2,500 feet in thickness.

In reply to an inquiry by Prof. MARTIN, he further stated that the insects found in the deposits at Florissant, Col., are more recent; these also include two species of birds, many plants, etc., which are evidently of later date than the fossils on exhibition.

Dr. N. L. BRITTON then spoke on the subject of

NOTES ON THE COPPER MINING REGION OF LAKE SUPERIOR.

The succession, probable stratigraphical relationship, and lithological characteristics of the rocks and veinstones of the region were described in detail, and illustrated by diagrams and a series of specimens collected during a visit of the past summer.

DISCUSSION.

Prof. O. P. HUBBARD stated that the first steamboat which navigated Lake Superior was drawn across the straits at the Sault in the year 1849. It was curious that this date was preceded in Russia, since the first steamboat navigated Lake Vega in the year 1842.

The PRESIDENT then gave a description of the geological structure at Ontonagon, in the Keweenaw peninsula, of the Porcupine Mountains, the distribution of the Potsdam sandstone, and of the underlying rocks, the Copper series, which in the Eastern States are represented by the Taconic or Cambrian slates, and on the north side of Lake Superior by the Anemikee rocks of HUNT.

Mr. C. VAN BRUNT referred to an ancient mining excavation along the south wall of a vein at Houghton. From this trench much copper had been extracted by the old miners, and charred remnants of wood and many stone tools were found at the bottom.

The PRESIDENT remarked on the ancient works of the Lake Superior region, which were much more extensive, notwithstanding the imperfect means and absence of machinery at the disposal of the prehistoric miners, than those of the whites, by whom these veins have been worked only since about the year 1847. The guide of the early explorations of the latter has been, almost invariably, the ancient works, mounds, and excavations of their prehistoric predecessors. The old works were never deep. The tools employed were rude stone mauls, sometimes very heavy, which were attached to handles by withes around a groove at the middle, and were slung by several persons; others were much smaller, and were handled by a single person. He had seen but one copper mining-tool which had been fashioned and used by them. The PRESIDENT also described the glacial phenomena of the Ontonagon region—the polish and striation of outcrops, abundant boulders, etc., and then referred to some of the most interesting papers recently read at the Minneapolis meeting of the American Association for the Advancement of Science. The papers of Mr. WM. MCADAMS were particularly important, describing his discoveries of the bones of some large, new fossil fishes in the Carboniferous limestone at Alton, Ill., the skull of the giant beaver (*Castoroides*), etc., in the Quaternary, and a large number of bones and teeth found at the bottom of the Loess or Bluff Formation; these last remains are likely to throw great light on the true character and history of the Loess.

October 29, 1883.

SECTION OF CHEMISTRY.

The President, Dr. J. S. NEWBERRY, in the Chair.

Thirteen persons present.

Prof. D. S. MARTIN exhibited a specimen of the ashes thrown out at the remarkable eruption of the volcano Krakatoa, in Java, during last August.

The PRESIDENT referred to a sermon, recently delivered in this city, in which these eruptions were cited as overturning modern geological theories, and he showed its mistake.

Dr. B. N. MARTIN exhibited a silver casting, of archæological interest, which was discovered by Messrs. LYMAN and SQUIER, in Peru, many years ago, and has recently been brought to this city. Several castings were found in one village, mostly domestic in subject, but the one exhibited presented possibly a religious form, and was so treated by the natives in whose possession it was found. On a thin, round tablet, twelve centimetres in diameter, was a figure of an Indian, with one knee bent, and a metal axe lying at his foot, facing a tree with a serpent at the base ; at his left was a pole, supported upon two forked props, beneath which was bound a human figure, face downward, over a square pile of fagots. The execution implied great skill in the prehistoric races of America.

The SECRETARY called attention to the peculiarity of the fact of the insertion of the handle of the axe in the socket.

The PRESIDENT referred to the remarkable skill in metal working of the South American and Central American races, as shown in the specimens found at Chiriqui and elsewhere ; but stated that he had never seen any one equal to that on exhibition. Other instances of their skill had been shown by the casts of figures in silver from Peru, which had been exhibited by Dr. OTIS several years ago, and the casts in an alloy of gold, copper, and silver, which had been "pickled" in some solution, leaving only the gold at the surface, and afterward polished. He described an axe of copper, from Chili, now in his own possession, which was exceedingly well wrought—better than any other he had seen. This was very ancient, and belonged to a civilization anterior to that of the present time. It had been bound to a handle with thongs of some kind, and he had never seen any American implement, of prehistoric age, which had been pierced for the reception of a handle.

Dr. A. R. LEDOUX then spoke on the subject of

THE RELATIVE SOIL-EXHAUSTION BY THE SUGAR-CANE CROP.

This communication presented an exceedingly interesting account of the systematic mode of cultivation of a very large sugar plantation

in Cuba ; the subdivision of its area into small plots ; the plan of bookkeeping, carried on for many years, by which a careful account is kept of the treatment of each plot, the fertilizers added, the products received, and its general condition. He then gave an account of an important and very costly series of experiments, carried on under his direction, to determine the chemical composition of the soil and sub-soil, at various locations and depths, of the cane at various stages of growth, and of the fertilizers required to bring up the entire area to the best agricultural condition. One important result was the recognition of the fact that the most important constituent of the soil, soonest exhausted by the cane, was phosphoric acid ; and satisfactory results had already been obtained by the addition of this substance to the soil. The experiments were still in progress on a large scale.

DISCUSSION.

Prof. W. P. TROWBRIDGE stated that on a recent journey, in company with Prof. J. D. DANA, the latter expressed the view—with which his own coincided—that, of the coming great scientific discoveries, the greatest would be in the application of chemistry to agriculture. The present influence of a scientific school or society, of greatest importance, consisted in the diffusion of scientific facts among the farmers of the country.

Rev. G. L. SHEARER remarked that a system and means provided in this direction lies in the Grange associations, now comprising a million and a half of members throughout the land. Some of these give attention to reforms in political matters, but much has also been done by others in regard to scientific education of the agricultural community, partly by the appointment of lecturers (chiefly through the Pomona Grange), who discuss many points of a scientific character. For instance, he had visited, last summer, a Grange meeting in Pennsylvania, which had been attended by thirty-five thousand people during the session of a week. It possessed various departments, one of which was a school, in which such subjects as the needs of particular soils, the fertilizers required, etc., were discussed ; this practically amounted to a summer school of agricultural philosophy, and was of the greatest service to the farmers present.

The PRESIDENT observed that the scientific interest and practical benefit of the experiments conducted by Dr. LEDOUX were so demonstrable that their continuance was highly desirable. In this country we have still so much virgin soil that the proper appreciation of the work of the agricultural chemist must come later. He had himself followed the march of empire westward, and the progress of the farmers

from lot to lot as they disposed of exhausted soil for fresher. Thus in New York, the oldest farms are now, after being occupied for a century, in no better cultivation than those in Iowa, which have been tilled but ten years. So far, there has been no incentive to thorough cultivation of the soil by the farmers, from the fact that they can sell their farms after exhaustion and buy virgin soil farther West at a much less price. After our people shall have reached the limit of migration they will return to the older soils, and better methods will come in vogue.

However, he had noticed already some improvement in methods of cultivation. Ohio used to be the greatest wheat-producing State, and the wheat belt was largely occupied by a race of farmers who had migrated from Pennsylvania and worked their Ohio farms more thoroughly and intelligently. Even within his own remembrance, the yield had run down from twenty-five bushels to the acre to half that quantity. Yet since then the processes had been improved by greater intelligence, and the yield had been considerably increased.

The experimental farms in Germany and other countries are doing excellent work; but they will only be properly appreciated in this country hereafter. There is a good time coming to the agricultural chemist, when there shall be a real demand for his best work. From the ignorance and apathy still prevailing, our agricultural schools have been for the most part failures ; but, with the exhaustion of the public domain, with its virgin soil, the farmers will be compelled to improve their methods of cultivation.

Mr. GEORGE F. KUNZ then exhibited the following series of minerals :

Deweylite, from the Cheever's iron mine at Richmond, Mass. This mineral is of rare occurrence there, in white masses, which resemble, and have been mistaken for, meerschaum, with occasional spots of yellow serpentine.

Aragonite (Flos Ferri), from the vicinity of Rapid City, Dakota. It is found in large groups in veins many inches wide, and equals the specimens from Styria in beauty, but its twisted stalactites are thicker than those of the latter locality.

Zircon, from Ceylon. A cut gem, weighing seven and one-eighth karats, of a light blue color by day and light green by artificial light, with an intensity and fire approaching that of a diamond.

Perofskite, from Magnet Cove, Arkansas. The mineral occurs loose in the soil in isolated crystals, or attached to groups of magnetite crystals. The original bed appears entirely decomposed, but the specimen exhibited was a mass of calcite enclosing scattered crystals of perofskite and magnetite. This gangue resembles that of the Rus-

sian locality ; but at Magnet Cove the cubical form is exceptional in the magnetite crystals, that prevailing being the octahedron, with the faces of the cube more or less developed.

Wavellite, from a new locality in Arkansas. It occurs not only on sandstone, but coating crystals of transparent quartz in small green radiations, closely resembling a prehnite. Limonite is associated with it, coating the quartz in the same way, and appears to be the result of alteration of the wavellite. The large and perfect spheres of the latter show a lighter color on fracture, which distinguish it from the form which is found in Montgomery County.

Spherostilbite and *chabazite*, from Tyringham, Berkshire County, Mass. They are found in a vein of pyroxene, attached to mica. The chabazite is white, resembles very closely that of Aussig, Bohemia, and occurs in crystals from one-eighth to one-quarter of an inch in length, associated with spherostilbite. The latter is found in beautiful isolated spheres up to one-quarter of an inch in diameter, in one case coating a hexagonal crystal of dark gray mica, and rivals any found elsewhere in this country. Isolated crystals of the mineral are rare.

Iron Garnet, from Russell, Mass. These crystals are remarkably well defined, of a dull brownish black color, usually trapehedrons with the faces of the rhombic dodecahedron slightly developed. They were found in a vein between coarsely crystallized mica and feldspar, with the interstices filled with quartz. They vary in size from one-quarter to three and one-quarter inches, and are found in beautiful groups which sometimes contain from fifty to one hundred and fifty perfect crystals.

November 5, 1883.

REGULAR BUSINESS MEETING.

The President, Dr. J. S. NEWBERRY, in the Chair.

Twenty-eight persons present.

Dr. ANTONIO DI GREGORIO, of Havana, Cuba, was elected Corresponding Member, and several of his published papers were presented to the Academy.

Dr. B. N. MARTIN exhibited specimens of copper ore, from the vein recently opened at Bloomfield, N. J., one foot and a half in width, containing twenty-seven per cent. of copper, and crossing a bed of shale impregnated with copper.

The PRESIDENT remarked that a large quantity of copper was ontained in the rocks of the Triassic formation, although no pay-

ing vein has yet been opened. The following localities were referred to ; the vein at Bristol, Conn. : the Schuyler Copper Mine at Belleville, N. J. ; many points along and on the east side of the Alleghany belt, and in the Rocky Mountains, both on their east and west slopes ; deposits which have been worked, though with little success, as well as the concretionary ore and copper replacing wood in the Indian Territory, New Mexico, etc. These latter indicate an extraordinary impregnation of a shallow sea, in which the Triassic strata were deposited, and the copper was thrown down in association with salt and gypsum. It is a question, yet unsolved, why these Triassic rocks were so impregnated with copper. Toward the old shore of this sea, more and more silver was thrown down with the copper, until near the margin, at Silver Reef, its quantity became sufficient for working. The deposit of these ores appeared to be one of the accompaniments of the extrusion of the trap.

In reply to inquiries by Profs. HUBBARD and MARTIN, the PRESIDENT further stated that masses of native copper sometimes occurred, but usually only scales, rarely pieces up to a half pound in weight ; and that ores containing even as low an amount as five or six per cent. of copper have been profitably worked.

In the Eastern States, the impregnation of the Triassic rocks with copper was apparently one of the results of the eruptions of trap through them, and the copper was perhaps derived from the Archæan rocks below, which contained much copper, brought up dissolved in hot water. In the West, the copper was probably contained in the drainage of the old lands which formed the shores of the shallow Triassic sea, and was precipitated by evaporation. Near the Wasatch Mountains, the western boundary of the Trias, the copper was associated with considerable silver, as at the Silver Reef Mines, and both metals were probably derived from the leaching of the old land which occupied portions of Utah, Nevada, etc., and which in ancient as well as modern times was a region rich in ores.

A number of curious crystals of calcium carbonate, apparently calcite, with hexagonal form, found in clay, at Laramie City, were then exhibited by a member, Mrs. WELD.

Prof. J. S. NEWBERRY read a paper on

THE RELATIONS OF DINICHTHYS, AS SHOWN BY COMPLETE CRANIA RECENTLY DISCOVERED BY MR. JAY TERRELL, IN THE HURON SHALE OF OHIO.

Drawings of these crania were exhibited. They showed that the head was shorter and broader than was formerly supposed, and confirmed the views expressed in the Report of the Geology of Ohio, that *Dinichthys* was closely allied to *Coccosteus*, but was a hundred times larger. The cranium of *Dinichthys* was strongly arched in life, but is flattened by compression in the fossil state. It is then triangular in outline, nearly three feet broad behind, and two feet long. The brain box was partly cartilaginous, but was enclosed in strong, continuous plates of bone. The fin rays and some of the vertebræ were ossified. The head was articulated with the body by the strongest, most complex and complete osseous joint yet found in nature.

November 12, 1883.

LECTURE EVENING.

The President, Dr. J. S. NEWBERRY, in the Chair.

Fifty-eight persons present.

The PRESIDENT stated that the crystals of a mineral from Laramie City, presented at the last meeting by Mrs. WELD, had been examined by Prof. BRUSH, of New Haven, who reported that they appeared to consist of aragonite, although enclosing some minute rhombohedral crystals, apparently of calcspar; but that he had never seen aragonite crystals possessing the same bevelled edges. The variety was entirely new.

Dr. HUBBARD W. MITCHELL then delivered a lecture, illustrated with diagrams and stereopticon, upon

THE SUCCESSION OF ANIMAL LIFE ON THE GLOBE.

November 19, 1883.

SECTION OF GEOLOGY.

The President, Dr. J. S. NEWBERRY, in the Chair.

Forty persons present.

A Communication was received from Dr. H. CARRINGTON BOLTON, of Hartford, Conn., presenting two specimens of a minute gasteropod, which had been recently found in great numbers upon

the flagging of the streets of that city, and were supposed to have fallen from the atmosphere.

The PRESIDENT stated that these shells belonged to the species *Bulimus lubricus*, called by Binney *Fenocyclea*. This shell was very widely disseminated throughout the country and abroad. It had not rained down, as suggested, but had probably multiplied to an unusual degree during the past summer, and was "swarming," as lemmings, butterflies, and other animals do; a mysterious migration, perhaps to escape over-crowding and the exhaustion of food.

Mr. G. F. KUNZ exhibited several remarkable specimens of Brazilian diamonds. Some were perfect spheres, one being of the size of a child's marble, and weighing over forty carats, 6.3 grammes (specific gravity, 3.5195). The latter consisted of a conglomerated mass of cubes, so bunched together as to have lost all crystalline form. The same bunching of crystals was illustrated by a spherical mass of common pyrite, and in others which revealed traces of crystalline form. This spherical shape was never produced in the diamond by rolling in streams. Another diamond of black color, weighing 1.2 gramme (sp. gr., 3.649) revealed no trace of crystalline form, perfectly amorphous. Another of gray color, weighing 1.6 gramme (sp. gr., 3.522), was also a vitreous mass, in which scarcely any crystalline form was apparent; this was also the character of a milky diamond exhibited, weighing 1.1 gramme (sp. gr., 3.522). One diamond, weighing over 6 carats, presented a table and culet, in which each alternate facet (eight on top), as well as the centre, was white, and all the other facets were a deep black. This was originally a white octahedron with a black coating; the slicing off of the four angles had produced the white faces. A crystal of South African diamond exhibited on an artificial surface of cleavage, the projection of the perfect four faces of an enclosed octahedron of the same mineral, with the corresponding impression of these faces in the slice cleaved off. A cut ruby from Siam was also exhibited, that enclosed a perfect octahedral crystal of ruby-colored spinel, about two millimeters in length. This inclusion had been considered, by the owner of the gem, as a serious imperfection, requiring removal, although it really added much to its interest and value, and the gem was in this case truly a ruby spinel.

Dr. N. L. BRITTON reported the abundant occurrence of kyanite crystals in the mica schist at an excavation near Madison Avenue and Fiftieth Street.

Dr. A. A. JULIEN referred to a locality of the same mineral near the corner of Ninetieth Street and Eighth Avenue.

Prof. D. S. MARTIN stated that it had been found in great abundance, as small crystals, throughout the schist at Forty-second Street and Park Avenue—in quantity sufficient to entitle the rock to the name, kyanite schist.

Dr. ALEXIS A. JULIEN then read a paper, illustrated by many specimens, on the subject of

NOTES ON THE GLACIATION OF THE SHAWANGUNK MOUNTAIN, N. Y.

The Shawangunk range marks the county lines of Orange County on its east, and Ulster and Sullivan Counties on its west. Its lowest summit occurs between Bloomingburg and Wurtsboro, 1,271 feet above tide water; its highest, about 1,700 feet. The lowest point in the Wallkill valley at its foot is found at the mouth of the Mongaup on the Delaware, 550 feet above the sea; the highest at Rondout, 773 feet; along this valley the Delaware and Hudson Canal has been excavated, with a descent of only 80 feet to the Delaware at Port Jervis. In this region the highest peak found is Walnut Hill, in the town of Liberty, Sullivan County, 2,130 feet above the sea.

The Shawangunk Mountain not only marks a line of upheaval and fault, branching southwestwardly from the Hudson River axis, but, along the greater portion of its course, it serves as a line of demarcation between the Lower Silurian area of the Wallkill valley on the southeast, and the Upper Silurian and Devonian terrane on its northwest side. At its upper extremity, near Rondout and Kingston, its trend is from a few degrees west of north to a few degrees east of south, but it soon assumes a southwestwardly trend, and so passes over the southern boundary of the State.

The Oneida or Shawangunk grit and conglomerate cap the range for a distance of 43 miles from the New Jersey line to the vicinity of Kingston on the Hudson, generally nearly horizontal on the summit of the mountain, dipping sometimes to the E. S. E. on its eastern flank, but generally westwardly, from 30° to 60°, on the northwest side, in the vicinity of Sam's Point. Its thickness usually varies from 60 to 150 feet, and the broken edges of the strata present mural escarpments of 30 to 200 feet in height, both in the gaps and along

the eastern flank of the range. Between Bloomingburg and Wurtsboro the mountain has been pierced by a railway tunnel, 3,857 feet long, and 340 feet below the summit of the mountain, which passed first through the Hudson River shales, and then through 850 feet of the Shawangunk grit, the beds standing at an inclination of about 60° toward the northwest.

Two systems of joints occur in this stratum—the one along the strike, N. 20° E. and S. 20° W., the other transverse, N. 60° W. and S. 60° E. With the latter are connected the lodes of galena and sphalerite at Ellenville, Homowack, and Wurtsboro, associated with crystallized quartz, pyrite, and chalcopyrite.

The general construction of the mountain, with its flat cap of conglomerate, its escarpments, and its view of the Great Valley and Hudson River, is suggestive of that of Lookout Mountain, Tenn.; and there is a further analogy in the abundance of huge rectangular masses of the rock, which have separated more or less from the edge of the escarpments, along the lines of the joints, but whose movement has sometimes been so small as to be distinguishable only at a distance by the slight alteration of the angle of dip. Such movements, often attributed to the action of floods, earthquakes, or ice, have been plainly caused here, as in the enormous conglomerate blocks of the "Ruined City," at Lookout Mountain, Tenn., and the similar fantastic masses along the precipices of the Catskills, by the slow undermining effect of rain-water and frost upon the underlying strata of thinly laminated grits and Hudson River shales. Some of the great and deep clefts, which result from these movements, form the natural "ice caves" of Napanoch and other points along the range.

Mather long ago has shown that "the Mamakating and Wallkill valleys, forming the Great Valley, an extension of the Champlain and Hudson valley, from its southwestwardly trend, would be in the natural direction of the set" of the ice current down that valley. The Shawangunk range, stretching along the western boundary of the Great Valley, received the full force of the ice-pressure and movement, of which a faithful and exact record remains to us in the character of its glacial erosion.

We will consider first the records of glaciation in the surrounding region. On the east side of the range, the rocks of the Wallkill valley consist chiefly of the Hudson River shales and lower soft shales and limestones, which have retained glacial markings only in exceptional localities, and most of which are buried beneath a thick layer of drift gravels, sands, and clays of Champlain age.

Both pebbles and huge boulders of many varieties of foreign rocks are scattered through and over this layer. Thus, near Newburg, I

have found rounded fragments of the Potsdam sandstone, gneiss enclosing graphite, and many kinds of granyte and gneiss, all of which must have been transported from the Adirondack region and its margin, as well as varieties of limestone which belong in the Helderberg range, near and southwest of Albany.

In Orange County, Dr. Horton observed numerous blocks of labradorite rock, rounded and very much worn, up to a weight of three or four tons, which are identical with the noryte of Essex County. These have also been traced all the way down the Great Valley to Pompton Plains, in New Jersey.

On the west of the Shawangunk range and of the Mamakating valley, the rounded hills mainly consist of graywacke and flagstones of Upper Devonian age, commonly capped by a thin stratum of conglomerate, which apparently belongs to the lower portion of the Catskill formation. This rolling surface, rarely over 1,000 feet above the sea near the Wallkill valley, rises gradually to an elevation of 2,000 to 2,500 feet to the northwestward, forming the high plateau of the centre of the State. This surface is in general but thinly covered by drift, and there is abundant opportunity everywhere to see that the surface of the rock is thoroughly planed down, grooved, and scratched.

The direction of the ice movement is shown by the following observations of Thompson and Mather, and which I have verified in the vicinity of Monticello :

Between Monticello and Bridgeville, common over all the ridges.....	S. 10°–15° W.
Bet. M. and Forrestburg, common on all elevated lands.....	S. 10° W.
Various parts of elevated lands in Sull. Co. (W. Thompson, Am. J. Sci., xxiii, 247)..	S. to S. 65° E.
Eastern declivity of mts. W. of Mamakating valley, furrows deep and distinct..... .	S. 78–80° W.
South of preceding and directed toward low gap in Shawangunk mts.....	S. 65° E.
Quarries at Coeymans (800-1000 ft. high)..	S. W. ?

W. Thompson found no grooves on the west side of the hills in Sullivan County, and that the grooves often ran eastward along the southern faces of the hills.

Many large boulders are scattered over the hills, in all cases of the slaty graywacke or of the conglomerate. One huge boulder of the latter material, about 20-25 tons in weight, forms a rocking-stone at a point 2½ miles west of Monticello, on the Newburg and Cochecton turnpike, at a height of about 1,400 feet above the sea. At Bridgeville on the Neversink, 4¼ miles east of Monticello, many such

boulders occur, perched often on narrow ridges which run to the river, and forming a marked feature in the scenery.

In regard to the material of the transported boulders and pebbles, a less variety occurs here than on the southeast of the Shawangunk.

A locality of great interest, which I have studied with some care, is at Mountaindale in Sullivan County, at a railroad cut one-half mile west of the station. This is situated in a little cross valley standing about W. N. W. and E. S. E., through which a small stream, the Sandburg, has cut its way into the Champlain deposits, leaving a series of well-marked terraces, sometimes six or eight, on either bank, and empties into the Mamakating valley. Across this little valley, at right angles to the course of the stream—so that it diverges northeastward, and so runs around close to the rocky bluff on its left bank—is thrown a huge natural embankment, like a dam, with a steep face on its N. W. side, and a long slope to the southeast; its height may be a hundred and fifty feet. The railroad cutting passes through the upper portion of this embankment, and the section gives a good view of its constitution, at least in its upper part, for a thickness of from 25 to 35 feet. The materials are varied in kind and size, and much mixed, although a rude sorting is shown by lines at intervals of six or eight feet in depth. The pebbles are mostly small, less than six inches in diameter. Many boulders of subangular form also occur, of one to two feet in diameter, and also a number of angular blocks, from three to six feet in diameter.

The material of the smaller pebbles, up to eight inches in diameter, largely consists of red shale, mostly in subangular tabular fragments, often containing fucoids. Also sandstone is abundant, fine to coarse grained, in pebbles of all shapes and sizes. White vein-quartz occurs, rarely in fragments exceeding half an inch in diameter, as well as several other varieties of shale, a reddish white quartz sand and a very little clay. All these materials are evidently of local origin, derived from the adjacent beds of sandstone and shale, with their occasional thin veins of quartz.

The larger blocks consist of graywacke, mostly of the vicinity, but, in a few much rounded boulders, apparently from the Catskill region, and all show an arrangement with the longer diameter in the plane of stratification. The number of large boulders, two feet in diameter or over, seems to be very small in proportion to the whole material. That taken out of the cutting has been used in the construction of a neighboring railway embankment, and the laborers have left along the sides of the track the boulders of a weight too great to be easily moved. Less than a hundred boulders thus remain, of three feet or more in diameter, and this would indicate a proportion of but a small

fraction of one per cent.,—as the cutting was about 600 feet long, 30 feet high, 15 feet wide below, and with sides sloping at an angle of 23°. A very large number of the pebbles and all the large boulders were thoroughly scratched and planed, sometimes with grooves a quarter of an inch in depth.

The mass appears to consist of materials swept down from the layers of till which covered the hillsides, and partly sorted and stratified by the floods which marked the beginning of the Champlain age. The locality seems to record two facts of interest :

1st. The rarity of Adirondack and other foreign material from the north in the deposits transported by ice-action through the Mamakating valley.*

2d. The occasional accumulation of glaciated till material in a mass of remarkable form, which suggests that of the terminal moraine of some small local glacier flowing southeastward from the high lands of the centre of the State.

The locality on the crest of the Range, at which I have had opportunity to study the phenomena of glaciation, is the well-known place of resort, Sam's Point. The stratum of conglomerate here is, perhaps, 100 feet thick, coarse toward the bottom, and passing upward into a coarse to fine white sandstone or grit, several yards in thickness, with gravel interspersed irregularly and in a few thin layers. The rock when altered consists of flat (perhaps flattened ?) pebbles of white quartz, generally from a half to two inches in diameter, in a small quantity of greenish-white cement ; the latter is ready to oxidize, and many parts of the weathered faces of the rock and of its joint surfaces thus assume a bright brick-red color, or sometimes brownish-yellow. The stratum overlies another of the Hudson River shales, and both are nearly horizontal in position, sometimes showing a dip of a few degrees to the northward. The upper surface of the stratum thus forms a long table-like plateau, whose surface is generally dry and covered by a thick growth of low shrubs, huckleberry, scrub-oak, etc.,† but marshy in many places. Not far to the north of the Point is a lake half a mile in length, partly occupied by grasses and white pond-lilies, and surrounded by a marsh. In passing over the surface, outcrops of overlapping conglomerate layers are constantly met with, and everywhere afford a record of the glaciation, in grooved, striated, and even finely polished surfaces. Along the edges of these outcrops and of the escarpment these glaciated surfaces have been largely eroded and effaced by a process of weathering which has scooped out rows and

* However, these materials must sometimes occur, since Mr. J. V. Morrison, of Wurtsboro', has found feldspar and mica in the drift of that vicinity.

† See notes on the Flora of Sam's Point, Bull. Torrey n. Club, Vol. x., page 121.

groups of shallow basins. The depth of these varies from a half an inch to 3 inches, sometimes reaching 15 inches, and their diameter from a few inches up to 3 or four feet. In the bottom of these basins lie many pebbles, partly those which have been loosened from the conglomerate, and partly less rounded chips which have been flaked up from the bottom, apparently by the action of frost.

So hard is the rock that it is rare to find any deep grooves. The scratches are mostly very shallow, rarely ¼ or ½ inch in depth, though often very numerous, long, and parallel. Very shallow and broad troughs, a half to one inch in depth, and several inches in width, generally occupy the polished areas and produce a gently undulating surface.

The direction of the striæ varies a few degrees on either side of northeast, as shown by the following observations noted :

S. 35° W.

S. 29° W.—abundant, very long, one-sixteenth of an inch in depth, counting 15 to a foot.

S. 41° W.

S. 46° W.—abundant.

S. 47° W.

S. 55° W.

and a few. ¼ inch in depth, S. 75° W. and S. 86° W. In following a long scratch southward, there seemed to be a tendency to curve more and more toward a point nearer the west.

The gap immediately below the Point is occupied by great rounded heaps and even hills of coarse till, made up of angular blocks of the conglomerate and sandstone. In a lower gap further to the southward, crossed by the road to the Point, a finer drift occurs, which was apparently not stratified, but, where cut by ravines running down to the westward, presented a series of 3 or 4 well-marked terraces. The interest attached to these observations depends on the fact of the high altitude of these till deposits, probably 1,000 feet above the sea, and far above the reach of the floods of the Champlain period. I had not the time nor opportunity to give them the thorough study necessary to unravel their true meaning.

I am indebted to Mr. John H. Caswell, of New York, for the following notes which he kindly made on the glacial striæ, near the northern end of the Shawangunk range, at and near Lakes Mohonk and Minnewaska. At this point, the trend of the range is from a little west of north to a little east of south. Lake Mohonk seems to occupy an irregular cleft with precipitous walls, and the horizontal surfaces of conglomerate adjacent to the lake are beautifully polished and striated in many places. Lake Minnewaska lies on the top of the range,

about five miles southwest of Lake Mohonk, and occupies a shallow basin of purely glacial origin. The observations were made in September, 1878, are uncorrected for magnetic variation, and are recorded in order along the usual path taken by visitors from the hotel to the summit of Sky-Top and back.

Near Bowling Alley...	S. 10° W.	
Eagle Cliff.....	S. 10° W.	taken at many different points along the path.
On the path.....	S. 10° W.	
On the path.....	S. 10° W.	
Chestnut path.....	S. 10° W.	
Cope's Lookout	S. 10° W.	on the northwestern side of the mountain.
Cope's Lookout	S. 10° W.	
Cope's Lookout	S. 10° W.	
Before Newlin's Cave..	S. 10° W.	
Before Newlin's Cave..	S. 10° W.	
Beyond Newlin's Cave.	S.	
Top of Crevice.....	S. 40° E.	on the southeastern side of the mountain.
Top of Crevice.....	S. 40° E.	
Sky-Top	S. 18° E.	
Sky-Top	S. 18° E.	
Giant's Workshop....	S.	Top of large flat rock at exit. This and the following observations, on the northwestern side of the range.
The Kitchen.....	S. 10° W.	
The Kitchen.....	S. 10° W.	
The Cottage	S. 10° W.	Large and beautifully polished surface.
The Cottage	S. 10° W.	
Road to Alligersville.	S. 40° E.	In the Rondout valley, on the northwest of the range.
Lake Minnewaska...	S. 10° W.	Furrows in front of the hotel, on the top of the mountain.
Lake Minnewaska...	S. 10° W.	

At this northern end of the range, where its own trend is about S. by E., the course of striation and the main glacial movement appear to have been about S. by W. The divergences from this direction in the instances noted, from S. even to S. E., appear in some cases to be merely local variations through valleys and around the shoulders of the range. Those on and near the summit of Sky-Top may possibly record the southeastern movement of the older and thicker glacial stream, to which reference has been more fully made in my observations on the glaciation of the Catskills.*

* Trans. N. Y. Acad. Sci., 1881, Vol. I., p. 24.

At the southern portion of the range, where it trends off decidedly toward the southwest, the glacial movement nearly conformed to the course of the valley, the upper part of the sheet scraping obliquely over the summit of the range.

The main body of the coarser detritus, gneiss, quartzyte, etc., from the Adirondacks, Helderbergs, and Catskills, borne along through the Hudson valley, was mainly diverted through the stronger glacial current which swept down the Wallkill valley. The approximate coincidence of the movement of the ice with the course of that valley, as well as the low planes—within or beneath the ice—at which the foreign boulders were borne or shoved along, have been the two causes which appear to me to have permitted little or none of this northern material to cross the Shawangunk range, even through its lowest gaps.

DISCUSSION.

Prof. D. S. MARTIN gave some account of the glaciation observed by him during a visit to Lake Mohonk, near the northern end of the range. At this point the cap of Oneida conglomerate is not less than three hundred feet in thickness. The hotel rests upon it, at the shore of the lake, which is 1,200 feet above the sea level, and it forms a continuous mass extending up to the summit of Sky-Top (altitude, 1,500 feet). He had observed the same form of bright red weathering at this locality. Near the lake, the fresh horizontal surfaces of the white quartzyte are polished like a slippery floor, which is even difficult to walk upon. He had obtained specimens of the conglomerate, showing pebbles sliced off by the glacial action.

MR. C. VAN BRUNT stated that the modified till was universally distributed, with boulders, over the area on the west of the range up to its northern termination. At that point particularly he had observed the shoulders of the ridges to be remarkably ground and scratched. He inquired whether the great masses of the conglomerate, loosened or detached along the escarpment, might not have been pushed away by the pressure of the ice.

Dr. N. L. BRITTON stated that he had visited the southern extension of the range, at High Point, which has an altitude of 1,700 to 1,800 feet. There also a small pond occurs, which is extremely shallow. The glacial striæ ran very nearly to the southwest. Not a single boulder of extraneous material was observed in the vicinity, except a small flat pebble of Helderberg limestone, which was found at a point about 300 feet below the summit.

Prof. O. P. HUBBARD inquired how the deep excavation of Lake Mohonk had been probably effected.

Dr. JULIEN replied that, judging from the general accounts of the

topography, the precipitous walls and angular forms, displayed by the lake-bottom, seemed to indicate the widening out or excavation of a fissure, perhaps along a fault, and the damming up of the basin by a mass of moraine material.

Although the action of ice, as a most powerful agent of disruption of thinly bedded sandstones and conglomerates, was most decidedly marked, both in the Shawangunk and the Catskills, nevertheless the separation of the huge loosened blocks of rock, now forming the brow of the escarpment, was evidently in most cases of much more recent date, slowly effected by the gradual widening of the joints by atmospheric waters, the removal and undermining of the soft shales which lie beneath the conglomerate, and the sliding of the ponderous masses down the slope.

Dr. N. L. Britton then remarked on the discovery by Mr. Arthur Hollick and himself, of

LEAF-BEARING SANDSTONES ON STATEN ISLAND, NEW YORK.

The locality is at the southern end of Staten Island, at the base of a bluff, facing toward the Bay. The blocks of ferruginous sandstone, in which the leaf impressions were noticed, lie scattered along the beach, between tide-marks, and are mingled with pebbles and boulders of many kinds of metamorphic and sedimentary rocks, and with diabase ; these have been washed out of the bluff which here marks the most southern extension of the great terminal moraine along the Atlantic coast. This fact lends an additional interest to the locality.

The sandstone is accompanied by a ferruginous conglomerate, and was not found in place, but presents the appearance of having been thrown up on the shore, the fragments torn from a sub-aqueous outcrop. The leaf impressions noticed were but fragmentary, and insufficient for proper determination ; it is hoped that further search will reveal more perfect specimens. Impressions of twigs occur in great abundance in the rock, but little regarding the character of the plants which formed them can be learned from this source.

The occurrence of similar fossiliferous sandstones on the beaches about Glen Cove, L. I., and vicinity, has been known for some time. There they are found in precisely the same position as at the locality above described, and are associated with extensive beds of fire-clay, "kaolin," etc. The Tottenville station is not immediately on these clays, but they are found near by in several directions. That the two places mark outcrops of the same geological formation, and probably approximately the same strata, is almost certain.

The physical structure of the Glen Cove series is exactly parallel

to that of certain of the clay beds of Middlesex County, N. J., which are well known to belong to the Cretaceous Epoch. In the absence of sufficient fossil evidence, we cannot state, with absolute certainty, that the two deposits are equivalent, but there is little doubt that this will ultimately be proved, and that the New Jersey and Staten Island clays, "kaolins," sandstone, lignite, etc., find another and their most northern outcrop on the north shore of Long Island. The speaker had already traced them as far as the Narrows, and intends continuing the investigation.

DISCUSSION.

Prof. D. S. MARTIN suggested that a map of these outcrops, drawn to scale, might throw light on the exact position of the Glen Cove specimens. They were remarkably like the Triassic rock, containing lignite stems, found in New Jersey, and may be drift material brought over from some such outcrop in that State.

Dr. BRITTON replied that the same specimen contained angiospermous leaves, and that no boulders of diabase were noticed at Glen Cove.

The PRESIDENT thought that more material was yet needed to render the determination of age absolutely sure. He had already exhibited similar specimens from Williamsburg, Lloyd's Neck, and Glen Cove, which enclosed large numbers of angiospermous leaves. These resemble those of the Raritan clays, but a further collection was needed to identify them, though such a result was probable. The association of clays with the sandstones at Glen Cove seems to prove the strata to be essentially like those at the mouth of the Raritan.

He further reported on some of the more interesting papers read at the recent meeting of the National Academy of Sciences.

The Academy then adjourned for two weeks, to December 3, on account of the Centennial Celebration, on November 27, of the Evacuation of New York City, in 1783.

December 3, 1883.

SECTION OF CHEMISTRY.

The President, Dr. J. S. NEWBERRY, in the Chair.

Twenty-seven persons present.

Mr. EDWARD F. DUSENBERRY, Dr. BENJAMIN LORD, and Prof. JOSEPHINE CHEVALIER, of the Medical College of the N. Y. Infirmary for Women, were elected Resident Members.

Lieut. ANTHONY W. VOGDES, U. S. A., was elected a Corresponding Member.

The PRESIDENT reported his receipt of a request from the American Museum of Natural History, for the removal of the Botanical Collections belonging to the Academy, and stated that they would be brought down and stored with the Annals in the building of Columbia College.

He exhibited a series of photographs of the ruins and desolation produced by the recent earthquakes in Ischia; also, an egg of the alligator from Florida, showing the young animal just protruding its head from the shell, with the end of the tail beside the jaws; also, a portion of a placoderm fossil fish from the Chemung of Pennsylvania, described by Prof. CLAYPOLE, under the name of *Pterichthys corrugatus.*

Prof. FREDERICK STENGEL had translated, at the request of the Academy, and now read, a paper by Prof. F. FITTICA, of the University of Marburg, (published in the Annals, vol. III.)

UPON A FOURTH MONOBROMPHENOLE.

DISCUSSION.

Prof. A. R. LEEDS considered these statements of the author of very great importance. He described the constitution of the benzole-ring of Kekulé, and stated that he did not see the potency of the *a priori* reasoning of Prof. FITTICA, nor any evidence of the existence of the monobromphenole—that he had really produced such a compound. The difficulties attending the solution of this question were much greater than might be supposed, to satisfactorily determine its difference from the other compounds of bromine and phenole.

Dr. B. N. MARTIN then called the attention of the Academy to the peculiar phenomena recently occurring in connection with the sunsets, and described the brilliant crimson colors which affected the western sky before and after the disappearance of the sun.

Prof. O. P. HUBBARD had observed in the morning also, at about 6 o'clock, that the entire heavens had been dyed in the same brilliant colors from west to southeast for half an hour. He also referred to a similar phenomenon on August 20, 1831. An insurrection was then in preparation among the slaves in Virginia, where he was at that time. Its leader had arranged for the outbreak on a particular day, somewhat later than the day mentioned, but the remarkable appearance of the sky induced him to begin it prematurely at that time. Among other phenomena, the sun assumed a decided green color every afternoon

for several days in succession. These facts were then very generally known and attracted much attention.

The PRESIDENT presumed that the appearances were being studied by observers of the heavens, who would yet definitely report upon them. He also referred to the facts known in regard to the locomotive appendages of trilobites, as recently discussed in an article of *The American Naturalist*, and to the discovery of tracks in Colorado.

He further remarked on the recent observations of Prof. ALEX. AGASSIZ, on the growth of the coral formation in the peninsula of Florida, and his own observations on the Gulf Coast, in confirmation of the view of the organic nature of the increase, with little, if any, assistance from elevations of the sea-bottom.

Prof. D. S. MARTIN called the attention of the Academy to the recent death, by typhoid fever, on Thanksgiving day, of Prof. ARTHUR SPIELMAN, one of the most promising Resident Members, from whom had been expected an important record of observations on the excavation of the tunnel beneath the Hudson River. He referred to the great ability, energy and activity of Prof. SPIELMAN, his remarkable engineering skill, and the great loss to society and the Academy by his decease at so early an age.

The President exhibited and described

SOME PECULIAR SCREW-LIKE CASTS FROM THE SANDSTONES OF THE CHEMUNG GROUP OF NEW YORK AND PENNSYLVANIA.

These he considered the remains of the stems of seaweeds, and compared with *Spirophyton*. Two distinct forms were shown, which he regarded as two species of a new genus, to which he gave the name of *Spiraxis;* this he defined as follows :

SPIRAXIS (nov. gen.).*

Body cylindrical or sub-fusiform, somewhat abruptly conical above, more gradually tapering below; surface traversed by two parallel revolving prominent ridges, in some species closely approximated, in others separated by an interval of half the diameter of the stem. No traces of internal structure or distinct surface-markings visible.

The two species are described as follows :

1. *Spiraxis major, n. sp.*

Body cylindrical; about one inch in diameter, terminating above in a conical summit, traversed by two strong spiral revolving ridges, which cross the axis at an angle of about 45°. These ridges are flattened or sulcated.

* Fully described and figured in the Annals, Vol. III., No. 7.

2. *Spiraxis Randalli, n. sp.*

Body fusiform ; three or four inches in length, by six to eight lines in diameter ; surface marked by two revolving and closely approximated ridges, which below are broad and flattened or rounded, and separated by narrow furrows, above acute and narrow, and separated by greater intervals.

From *S. major* this species may be distinguished by its smaller size, its somewhat curved or sinuous outline, and the closer approximation of the raised ridges, which are also more flattened and relatively broader.

December 10, 1883.

SECTION OF GEOLOGY.

The President, Dr. J. S. NEWBERRY, in the Chair.

One hundred and forty five persons were present.

The PRESIDENT exhibited fine specimens of terminated crystals of black tourmaline from Jefferson, St. Lawrence County, N. Y., somewhat similar to those which are found at Monroe, Conn.; also some large specimens of moss agate from Brazil, and remarked on their mode of formation. The resignation of Dr. HIGGINS, from resident membership, was read and accepted.

Dr. J. S. NEWBERRY and Prof. H. L. FAIRCHILD then presented a joint paper, illustrated with a large series of original lantern views and by specimens, on

THE GEOLOGY, BOTANY, AND SCENERY OF THE YELLOWSTONE NATIONAL PARK.

December 17, 1883.

SECTION OF CHEMISTRY.

The President, Dr. J. S. NEWBERRY, in the Chair.

Sixteen persons present.

Dr. NEWBERRY exhibited a specimen of fossil fish from Wyoming, presenting an interesting character of dentition ; also a series of maps of the surveys of the route of the Northern Pacific Railroad.

The following papers were then read by Prof. ALBERT R. LEEDS :

I. THE LITERATURE OF OZONE AND PEROXIDE OF HYDROGEN (second memoir), published in the Annals, vol. III., and including—

1. Historical-critical resumé of the progress of discovery since 1879.

2. Index to the literature of Ozone, 1879—1883.

3. Index to the literature of Peroxide of Hydrogen, 1879—1883.

And also,

II. FACTS GATHERED FROM EIGHT YEARS OF PERSONAL INSPECTION AS TO THE ALLEGED DESTRUCTION OF THE ADIRONDACK FORESTS.

In this paper Prof. LEEDS urged some action of the Academy, in co-operation with the present public movement, to protect and preserve the forests of the Adirondack region.

DISCUSSION.

Prof. O. P. HUBBARD remarked that nearly fifty years ago a feeder from the Black River was surveyed and constructed to the sources of the Mohawk to *bring water* to the *middle section* of the Erie Canal, the *summit level* between the Lakes and the Hudson River; and subsequently a *canal* even was built from Booneville to Rome, in part to bring a greater supply. When the hemlock forests back of Newburg, where immense tanneries once existed, were exhausted, there was a transfer to the southern border of the Adirondacks north of the Mohawk, where a similar destruction has been going on. This region, though very favorable for grazing, is not attractive on account of the climate for general agriculture; and great proprietors, like Brown, of Providence, and Gerrit Smith, of New York, never succeeded in attracting settlers, though land was offered at a few cents an acre.

It should be considered, however, that forests can be renewed, if protected in time. In thirty to forty years a tract may be reforested with the soft and hard woods, as the experience of cultivators in foreign countries and in our land has shown—one of the former, in the last century, having planted fifty millions of forest trees on his estate in Scotland, besides what he has sown and *not transplanted, which cannot be numbered.* ("Diary and Letters of Gov. Thomas Hutchinson," 1884, p. 343.) If all small landholders, farmers, and citizens, who have only a garden, would encourage their boys to plant the seeds of apples, pears, and fruits in general, also the walnuts, chestnuts, beechnuts, butternuts, and English walnuts, maples, elms, oaks, pines, hemlock, larches—there might be, if properly transplanted, hundreds of millions of valuable trees added to our stock in forty years.

The encouragement of this industry by means of premiums given by the State is a thousandfold more important than all ever paid by our agricultural societies for large vegetables and small extraordinary crops, and would add vastly to the wealth of the State.

In the higher parts of New Hampshire and Vermont, in the lati-

tude of the Adirondacks, great numbers of farms, on account of the cold climate and the exhaustion and washing away of the soil, are deserted, the houses and barns going to decay, and the forests are recovering the old ground, and in many parts, it is said, the annual growth is greater than the consumption, which is the best thing that can happen there.

It is not unimportant to all the inhabitants that the Adirondacks afford a home and range to nearly all the animals native to New York, and we hope the time may never come when they shall be annihilated or driven off as the buffalo has been from his entire eastern range, and when the naturalist can no longer study them in their native haunts.

Dr. MARTIN inquired how far the forests had been hitherto so utterly cut off as to render their replacement impossible.

Prof. LEEDS replied that the trial has been as yet too short and irregular to show. It was a common occurrence, where an area had been burned over, that a different growth of trees, chiefly the white and yellow birches, sprang up in place of the original forest.

Prof. HUBBARD added that the question of the differences between the succeeding and original forest growths, to which Prof. LEEDS had referred, was one of great importance, and yet needing satisfactory solution.

The PRESIDENT remarked on the importance of the subject and its claim to public attention.

There can be no question as to the damaging effects of cutting off forests. The subject has become very important in all parts of the country, since the forests were more valuable and remunerative than corresponding areas in farm lands. When the forests were cut away, the streams were dried up, the climate was sensibly altered, and the rivers became liable to sudden floods. He had encountered a notable illustration of this result. While once travelling in Kansas in a region without trees, his party encamped one night on the bank of a stream then fordable, but the next morning, in consequence of a storm, it had risen forty feet; the flood, however, subsided entirely during the course of a single day. Forests act as a blanket to protect the soil from the action of wind and sun, and at the same time as sponges to receive, retain, and slowly distribute the rainfall. In Europe the subject of forest preservation and propagation is embraced in the system of education, and schools of forestry have been widely established. Some action of the Academy is desirable in order to strengthen the hands of those who are interested in the protection of our forests.

Dr. N. L. BRITTON moved the appointment of a committee of three

by the Chair, with Prof. LEEDS as chairman, to represent the Academy on the subject of the protection of the forest lands of the Adirondacks, and to memorialize the Legislature of the State to that end.

The motion was passed, and the PRESIDENT appointed as such committee, Prof. A. R. LEEDS, Dr. B. N. MARTIN, and Prof. O. P. HUBBARD, to report to the Academy on this subject.

On motion, the Academy then adjourned to January 7, 1884.

January 7, 1884.

REGULAR BUSINESS MEETING AND SECTION OF BIOLOGY.

The President, Dr. J. S. NEWBERRY, in the Chair.

Thirty persons present.

The resignation of Dr. LOUIS ELSBERG as Librarian was accepted, and the nomination of Dr. ALEXIS A. JULIEN by the Council to fill the unexpired term having been received, he was so elected. The resignation of Mr. HENRY P. EGLESTON and J. H. MAGHEE as Resident Members were received and accepted.

On motion by Prof. J. J. STEVENSON, the preparation of a memorial of the senior Vice-President of the Academy, recently deceased, Dr. BENJAMIN NICHOLAS MARTIN, was directed and entrusted to the following committee : Profs. O. P. HUBBARD, A. R. LEEDS, J. J. STEVENSON, and the PRESIDENT of the Academy.

Prof. LEEDS, the Corresponding Secretary, read letters of acceptance as Corresponding Members from Lieut. A. W. VOGDES of Fortress Monroe, and Prof. ANTONIO DI GREGORIO of Havana.

Prof. STEVENSON nominated Prof. WILLIAM KING, of Glenoir, Galway, Ireland, as Corresponding Member, and he was so elected.

Mr. G. F. KUNZ called attention to an erroneous statement in the January number of the *American Journal of Science* (Series III., Vol. XXVII., page 73), setting forth the discovery of herderite, at Stoneham, Me., as follows : "These crystals were found in the pockets that yielded the fine crystals of topaz described by G. F. Kunz (See *Am. Jour. Science*, Series III., XXV., page 161)." In fact, however, the herderite was not found in these pockets, not at the time, nor in the same part of the ledge. The first crystals came under his notice in October, 1883, and were found by Mr. Edgar D. Andrews. They were never taken for topaz by himself, although so mistaken by others. As he did not own these crystals, they never came into his possession, and he was able to procure only some part of them on December 12, 1883.

Mr. KUNZ then exhibited a collection of beryls and emeralds from North Carolina. The specimens exhibited were sent to him by Mr. J. A. D. STEPHENSON, of Statesville, N. C., the most earnest and successful local collector of the minerals of that State, who was the first to call the attention of the outside public to North Carolina minerals, and also that of mineralogists to the beryls and spodumene (See papers on emerald, by W. E. HIDDEN, *Am. Jour. Science*, 1881, Series III., XXII., 489; and on hiddenite, by J. L. SMITH, *Am. Jour. Science*, 1881, Series III., XXI., 128), and also to many other localities.

In a letter he states: "These emeralds occur on the property of Mr. J. O. Lackey, about one mile southwest of the Emerald and Hiddenite Co.'s property, Stoney Point, N. C., a short distance from the Lyons property (Smeaton's), and are found in a vein of black decomposed mica, associated with quartz crystals, common rutile and hiddenite. I consider the locality a promising one, although there has been but very little work done as yet."

The lot received from Mr. STEPHENSON consists of 33 crystals, 10 mm. to 55 mm. (2 inches) long, and 1 mm. to 8.5 mm. wide, and varying from colorless to a light emerald green. Nearly all have the curious saw markings in considerable numbers on each corner of the prism, and some contain simple crystals of rutile. The interest attaching to these crystals is in the fact that they are found at some distance from the Emerald and Hiddenite Co.'s property, and that between these we have the Lyons property, on which Mr. SMEATON found the same minerals, showing that the deposit is not an accidental one, and that there is encouragement for future work in this section of the State.

The PRESIDENT then exhibited a specimen of a fossil landlocked skate, or ray, from the beds of fresh water lakes of Eocene age, in Wyoming—the same locality from which he had already shown specimens of fossil fishes and plants. The rays of the present day inhabit the salt water, and there occur in great numbers. These present an extreme prolongation of the vertebral column, carrying the sting. In resh water they are very rarely found, one living species occurring in Lake Nicaragua. He also exhibited specimens of argentite and native silver from Batopilas, Mexico.

Dr. N. L. BRITTON then read the following paper:

NOTES AND CRITICISMS ON MR. GRANT ALLEN'S THEORY OF THE ORIGIN OF LEAF-FORMS.

Mr. GRANT ALLEN'S recent papers on the "Forms of Leaves" and their origin, printed in *Nature*,* and elsewhere, must have been

* Nature. Vol. XXVII., pp. 439, 464, 492. 511, 552.

read with much interest by students of natural history; and his theory there advanced, that serrated, lobed, and divided leaves have attained these forms by struggling with others for their required supply of carbonic acid and sunlight during very long periods of time, by a process of gradual change or evolution from an originally entire-margined leaf-form, has appeared to us, to say the least, ingenious.

There are, however, considerations which will not allow us to accept this attractive theory without question; to some of these I propose in this paper to allude, using familiar examples illustrative of what is presented, as well as some observations and ideas of my own, indicative of what seem to me to be more probable causes by which the modification of leaf-forms is effected than those advanced by Mr. ALLEN.

The various marginal and ultra-marginal modifications of leaves—the serrations, lobations, divisions, etc.—and their plans of venation seem mutually dependent on each other. In nearly all plants bearing non-entire leaves, we find that the primary vein system, or strong branches from it, the system of channels which conduct the main supply of sap to the various portions of the laminæ, ends in the teeth or lobes,* and, consequently, these parts obtain a greater amount of nutrition than the portions immediately around the bases of the serratures, sinuses, etc. The leaf is but an expansion of a portion of the stem, with a greater development of parenchyma; the prosenchymal elements are expanded into a reticulum, on which the parenchyma is stretched, and these woody parts, bearing the intimate relation to the marginal indentations above alluded to, should be given more prominence in a discussion of this subject than those consisting mostly of parenchyma alone, the cells in which the decomposition of carbonic acid is effected by the aid of sunlight. Mr. ALLEN has given the parenchyma sole importance in his theory, and assigned the vein system no function in the production of teeth, lobes, etc. In entire-margined leaves we find that the primary veins seldom end in the margin, but curve upward, and ultimately become united with one another, forming the closed areas known as areoles.

Mr. ALLEN'S views fail to explain the fact that the leaves of monocotyledons are almost invariably entire-margined.† Many of these plants, and the grasses and sedges in particular, grow closely packed together, the leaves of individuals overshadowing those of others and

* There are exceptions to this general statement, as in the genus *Cicuta*, where the veins end in the serratures, and in some species of *Trifolium*, where they terminate abruptly in the practically entire margin.

† There are exceptions, as in *Yucca*, *Dasylirion*, and *Aloe*, and other related genera, with filamentous or spiny projections from the leaf-margins, and *Stratiotes aloides*, L., the European "water soldier."

their own lower ones, closely approximate to, and often touching them; yet here no marginal irregularities are seen, except a mere roughening of margins and midrib. Many of the orchids and liliaceæ grow in closely shaded places with leaves of other plants packed densely around them, yet their leaves are entire. Only the palms, the highest of these endogens, bear compound leaves, but their pinnæ are entire. If Mr. ALLEN'S hypothesis were true, we should certainly expect to find marginal indentations on the leaves of most endogenous plants having this habit of growth. The monocotyledons are plants of a very old type, having appeared on the earth, geologically, long before the angiosperms,* and hence there has been very much more time for them to have undergone changes in leaf-forms, but these remain very much as they began. In their case there seems to be a perpetuation of an ancient character dependent on a primitive plan of parallel venation, which the imaginary "struggle" for carbonic acid has failed to alter.

The leaves of angiosperms hardly appear to have become more serrated and lobed since their introduction into the earth's flora at the beginning of the Cretaceous epoch. The earliest of them, as represented by specimens from the Dakota sandstones and New Jersey plastic clays, are probably not less serrated nor lobed than the leaves produced by plants of the same genera now living. That there has been a change is of course possible, although it may justly be objected, that very little is known to us of that early angiospermous flora compared with our knowledge of the present one. But we will admit that a change in this direction may have taken place from natural causes, *i.e.*, that leaves are now marginally modified to a greater extent than they originally were, although the palæontological evidence of this change is wanting.

The object of the chorophyll-bearing parenchyma of the leaf is primarily the absorption and decomposition of carbonic acid, and it effects this in proportion to the amount of stomata-bearing surface; an entire-margined leaf accomplishes this more economically than a lobed one with the same system of venation, for the surface is greater, and the *advantage* of lobes, divisions, etc., under this view is difficult to apprehend.

Again, the well-known laws of the phenomena of diffusion of gases † render it quite certain that the amount of carbonic acid in all parts

* The oldest hitherto discovered plant of probable monocotyledonous affinities is *Pothocites Grantoni*, Paterson, perhaps allied to the *Araceæ*, remains of which have been found in the Carboniferous bituminous shale of Granton, Scotland, and described in Trans. Edinb. Bot. Soc., vol. I. Undoubted endogens occur abundantly in the Trias and Jura. No true angiosperms are known lower than the basal Cretaceous strata.

† See GANOT, Elementary Treatise on Physics, p. 135.

of the atmosphere is a nearly constant quantity. Its absorption through the stomata is certainly not rapid enough to seriously diminish this quantity; for the molecules taken up are immediately replaced by others from the surrounding atmosphere, maintaining a practically constant tension of the gas, without any action on the part of the plant. Chemical analyses of the atmosphere from widely separated localities, and under differing conditions, show that the amount varies only very slightly from one part of CO_2 in twenty-five hundred parts of air, measured by volume. And the total amount taken by plants from the air during any period is small when compared with the total quantity present—this loss being constantly replaced in various ways.

For these reasons it appears that Mr. Allen's theory is hardly in accordance with known facts, and must be abandoned if something more rational can be suggested.

It has seemed to me that the chief agency of the production of marginal indentations is to be looked for from a *mechanical*, rather than a chemical or vital cause, and this combined with more or less well-defined types of venation, no matter how originated, and also with relative amounts of sap nutrition and consequent relative vigor of different leaves on the same plant, or of those borne by young plants or shoots as compared with those of older individuals or branches.

That there is a general plan in the vein-arrangement, is apparent from the fact that in genera where some species bear nearly entire-margined, and others serrate, cut, or even compound leaves, or where this circumstance obtains in related genera,* the venation is generally similar; and this is true even of some orders.† We know also that the vein system has existed as long as the plants have; for in the *Sassafras*, *Liriodendron*, etc., of the Lower Cretaceous, it is the same as in living species of these genera, or similar, and is recognized by students of palæo-botany as a valuable means of determining genera. The origin of these various plans of venation, the "architectural ground-plans" of leaf-structures, I do not propose to discuss.

The amount of nutriment furnished the leaves by the roots is an important element in the discussion. This is relatively greatest at the time of vernation, and as other leaves appear on a growing branch or stem, above the earlier ones, part of the sap is diverted into these newer laminæ at the expense of those below; and this consideration will explain the fact that on land-plants bearing heterophyllous leaf-blades, the lower leaves are generally the most divided, although, from their earlier supply of sap, the largest. In germination the earliest leaves are mostly entire, from a similar cause. The nearer approach

* In *Negundo*, the leaflets placed together form a perfect maple leaf.

† The peculiarly characteristic venation of *Melastomaceæ*.

to entireness of margins in the younger and consequently more vigorous, better fed leaves of saplings is explainable in the same manner. This is well exemplified in some of our native oaks, particularly in *Quercus coccinea*, L., *var. tinctoria*, Gray, and often in *Quercus nigra*, L. This varying supply of sap-nutriment then produces variations in leaf-forms, and it is not improbable that these may now, and in past time have become specifically permanent, and here we may have one potent cause of the production of marginal modifications.

The mechanical cause of the origin of leaf-forms which long ago suggested itself to me is simply resistance to cell-formation by the medium in which growth takes place, be this air or water.

Let us first consider the case of submerged leaves, which are notably the most cut and divided of all, remembering that the density of water is many times that of the atmosphere. We may conveniently divide these into three classes: (1) plants whose natural habitat is moist ground, but which sometimes (by an unusually wet season, or other causes) have their lower leaves covered by water; (2) plants growing naturally in the water with their lower leaves submerged, their upper ones exposed to the air, either floating or immersed; and (3) plants wholly submerged.

Mr. ALLEN has stated that "gases are not very abundant in water, as it only holds in solution a limited quantity of oxygen and carbonic acid."* Certainly the quantity is small compared with the mass of water; but although water can dissolve only $\frac{26}{1000}$ of its volume of oxygen, there is enough of this gas to support a more redundant animal life than exists on the land. As to the actual amount of carbonic acid dissolved in waters, there is little exact information, as this substance is not determined in ordinary water-analysis. However, "in the autumn of 1859, W. A. MILLER found that a litre of Thames water at Woolwich contained 63.05 c. c. of dissolved gases, of which 48.3 c. c. was carbonic acid; and at Kingston, a litre from the same river contained 52.7 c. c. of dissolved gases, of which 30.3 c. c. was carbonic acid."† If river water contains this percentage, ponds, and particularly partially stagnant waters, in which the greatest quantity of submerged plants are found, certainly contain much more, water being capable of dissolving its own volume of CO_2.‡ It would appear then that Mr. ALLEN has underestimated the percentage of carbonic acid in waters; the percentage certainly far exceeds that carried in the atmosphere.

(1.) The first class of water-plants, to which I have above alluded, is well exemplified by *Sium cicutæfolium*, Gmelin. In this plant the

* The Evolutionist at Large, Humboldt Library, Vol. II., No. 26, p. 10.

† See "Water Analysis," by J. ALFRED WANKLIN, M.R.C.S., p. 90.

‡ GANOT, Elementary Treatise on Physics, p. 136.

naturally pinnate leaves with serrate pinnæ become much incised and laciniated by mere submergence alone, without the necessity of invoking evolutionary processes through intermediate forms; and this is wholly due to lesser amounts of parenchymal development, for the vein system is practically alike in the two forms of leaves. Here there is evidently a greater resistance offered to the formation of tissue by the denser medium, water, in which it takes place, and the chlorophyll-bearing cells forming the stomata-bearing surfaces are restricted to narrow bands bordering the stronger veins. I have twice observed this fact.

(2.) *Ranunculus multifidus*, Pursh, some forms of *Ranunculus aquatilis*, L., and *Proserpinaca palustris*, L., are good examples of my second class; and here the same arguments hold good, for, as I have repeatedly observed in *Ranunculus multifidus*, Pursh, and the *Proserpinaca*, it depends entirely on the depth of water and the consequent relative amount of submergence of the plants, how many of the leaves are dissected into narrow lobes, and how many remain normal. In the yellow *Ranunculus*, moreover, we find plants growing on shores, and not at all submerged, bearing only normal leaves; and this character is so well marked that this form has been given the rank of a variety in the Manuals of Botany (*var. terrestre*). In both *Ranunculi* the dissected lobes of the sub-aqueous leaves are somewhat prolonged by the stronger growth at the ends of the main veins as compared with that of their lateral branches. In all such leaves the formation of cellular, stomata-bearing tissue is reduced to very small amounts by the resistance of the water.

Another kind of dicotyledonous water plants may here be noticed. I refer to the *Nymphæaceæ* and the genus *Limnanthemum*. These bear nearly always entire-margined leaves,* the growth taking place at the contact of air and water, where the resistance is very small. Another interesting feature of these plants is the existence of thin, delicate, submerged leaves on *Nuphar parvulum*, Smith,† and *Limnanthemum lacunosum*, Griseb.‡ In these leaves the failure to produce the normal amount of parenchyma is evidenced in a reduction of the number of layers of cells, the resistance here causing a diminution of growth vertically instead of laterally.

(3.) In plants bearing leaves all normally submerged there is less direct evidence of the manner and cause of their capillary origin. *Hottonia inflata*, Ell., *Ceratophyllum demersum*, L., and *Proser-*

* In *Cabomba* we have small, entire margined, floating leaves, and large, dissected, submersed ones. In one or two species of *Nymphæa* the leaf is somewhat dentate.

† Gray, Manual, p. 57.

‡ Bull. Torr. Bot. Club, x., 34.

pinaca pectinacea, Lam., are good examples of this class. If we accept as true the proposition that leaves were originally entire, we must assume some system of change from less divided-leaved progenital species, not by a search for carbonic acid, as Mr. ALLEN has imagined, but caused primarily by resistance offered by the water.

The origin of the multiform leaves, borne by plants whose natural habitat is dry land, is much more obscure. The theories advanced by Mr. ALLEN certainly will not answer. But taking the facts before mentioned in regard to the variable amounts of nutriment received from the roots, together with the existence of a well-defined system, a venation, and the fact that all vegetable growth is affected under the atmospheric pressure of fifteen pounds to the square inch—certainly an appreciable amount of resistance, and also against the attraction of gravitation—I think we have data which will explain some, if not all of the marginal modifications of leaves.

Mr. ALLEN'S papers on this subject have been widely, and very generally unfavorably criticised.* I do not here propose to offer other objections to his theories, or his style of imaginative evolutionary deduction, although there are many statements in the papers here alluded to, which should be seriously considered before accepted as exact.

DISCUSSION.

Dr. SCHÖNEY observed that agriculturists give no clue to the cause of this variation in leaf structure. The Japanese maples have been found capable of a wide modification. However, experimental cultivation has not thrown light upon the causes of these changes.

Miss E. G. KNIGHT stated that in the fern leaves the ribs correspond to the interspaces between the veins. In *Salisburia* all the terminal leaves and all the older leaves are much more laciniated.

Prof. DAY suggested that plants growing in loose sand, and thus liable to be covered by sand and earth, were found apt to be divided.

Mr. C. F. COX said that he had given some attention to a similar subject, and that, if any criticism were to be made upon the paper just read, he thought Dr. BRITTON had confined himself too exclusively to the merely mechanical or physical view of the matter, and had not allowed sufficient weight to physiological considerations, particularly in reference to the differences between the shapes of aerial and of aquatic leaves. It seemed evident that the parenchymal tissue was spread out upon the fibro-vascular skeleton for the purpose of expos-

* See W. T. THISTLETON-DYER in Nature, XXVII., 54; notes by F. O. BOWER, *ibid.*, 552; note by Sir JOHN LUBBOCK, *ibid.*, 605, where he indicates his opinion that the cause of lobing is a mechanical one; note by E. M. HOLMES, *ibid.*, XXVIII., 29; also, L. P. GRATACAP, in Bull. Torr. Bot. Club, June, 1883.

ing a certain amount of cellular structure to the surrounding air or water, with relation to the favorable operation of either one or both of the great physiological functions—the assimilative and the metastatic processes. Since in nature the employment of material, like the expenditure of energy, is directly proportioned to some necessary end to be attained—there being neither waste nor deficiency,—we are forced to the conclusion that the differences in at least the *quantity* of leaf substance have an essential connection with the varying physiological requirements of plant life; and when the problem of leaf-forms is fully solved, it can hardly be doubted that here, also, physiological causes will be found to be the most potent and the most important. We know already that, as to their structure, the partially submerged plants of the order Nymphæaceæ stand upon a dividing line between the fully aquatic and the strictly terrestrial orders, the conditions of their environment necessitating certain adaptations of material means to physiological ends,—as, for example, the apparent transference of the epidermis with some of its organs (stomata) exclusively to the upper side of the leaf, and of some other organs, usually external (trichomes), to the intercellular air passages, which are uncommonly large. These peculiarities of structure are plain indications that physiological functions, which are performed by certain forms of leaves growing in the air, may require a change in the forms of the leaves when growing partially in the water; and they establish at least a strong probability that totally submerged leaves become entirely incapable of performing some of the functions of aerial leaves, and consequently differ from them in both structure and shape. It is therefore quite likely, as Prof. DAY has suggested, that the submerged filiform leaves have reverted to a more fibro-vascular and less cellular structure, simply because of a lack of physiological use for a greater parenchymal system, by reason of the nature of their habitat.

Dr. BRITTON stated that he had not combated the idea of the influence of an insufficiency of carbonic acid in the water.

Mr. COX further remarked that the stomata were almost wanting in submerged leaves.

The PRESIDENT observed that the plants which check the progress of drifting sand are chiefly the Gramineæ. Others, which grow in sand, have broader leaves—*e.g.*, the *Cucurbitaceæ* (watermelons), several species of *Abronia* in the Far West, etc. Experiments could be made which would throw much light on this subject, *e.g.*, by means of tanks of water containing varying amounts of carbonic acid, or by growing plants under pressure, etc.

The forms of leaves were so infinitely diversified as to constitute an almost inexhaustible subject of study, and the cause or causes of this

diversity have not yet been investigated with the thoroughness and philosophical method through which the truth will be discovered if within our reach. Certain broad generalizations could be made in regard to the forms of leaves, which were based upon striking and suggestive facts, but the explanations offered were for the most part mere speculations. As a general rule the submerged leaves of aquatic plants were dissected, while the emerged or floating leaves were broad. This is true not only of the cases cited by Mr. BRITTON but of many others in the recent flora, and it had prevailed through all geological ages. When a boy he discovered that the well-known plant *Sphenophyllum* of the Coal flora had dimorphous foliage; the lower leaves were capillary, constituting many of the species of the genus *Asterophyllites*, while the summit leaves were broad wedge-shaped; and on terminal branches carrying such leaves, the genus *Sphenophyllum* was founded. From these facts he inferred that this was an aquatic plant growing in the lagoons of the Coal marshes, with only its terminal branches and leaves exposed to the air. In a paper read before the American Association in 1853, these facts were given and illustrated by figures in the Report of the Proceedings of that meeting. Ten years later the same facts were reported by the Belgian palæontologist, Coemans, as discovered by him.

The functions performed by the emerged and submerged leaves of aquatic plants are evidently different. They are exposed to different media, air and water, and the differences in form and structure evidently hinge upon the differences in the media, and in the functions performed, the blades of the emerged leaves are both exhalent and absorbent organs, exhaling moisture and oxygen and inhaling carbonic acid, sometimes oxygen, and often absorbing water; the submerged leaves have probably a more limited range of function, are simpler machines, and they have less to do and that of a simpler kind. The pressure of the water may determine the form of the leaf, but it can hardly be accepted as counting as a mechanical impediment to the formation of parenchyma; for in some submerged plants, such as *Myriophyllum ceratophyllum* and *Ranunculus aquatilis*, the leaves are so numerous that the area of parenchymatous surface must be as large as in almost any aerial plant. The thread of prosenchyma in a submerged leaf filament bears perhaps as small a ratio to the parenchyma which encircles it, as the skeleton does to the parenchyma of an emerged leaf.

Among terrestrial plants the most striking and yet unexplained difference of form is observable; for example, the coniferæ as a rule have extremely narrow leaves and derive their German name of *needle trees* from their acicular form. But to this general rule we have

striking exceptions in the broad leaves of *Gingko* and *Phyllocladus*. On the other hand *Ephedra*, like many other desert plants, is almost without leaves. In the ferns and umbelliferæ also we find the foliage very much dissected, almost as much so as that of aquatic plants—why, no one has yet given us a reason.

It has been suggested that the earlier forms of leaves were simple, and that they have become compound by variation in descent. The ancient history of plants, which I have studied with much interest, gives no support to such a theory. The groups of terrestrial plants which earliest assumed importance were the conifers and the lycopods, but they have retained practically the same forms of foliage from the earliest times to the present; the living *Lycopodium dendroideum* being almost an exact copy in miniature of the Lepidodendra of the Coal Measures, while the Mesozoic and Palæozoic conifers exhibit the same scaled or acicular leaves that characterize the most abundant conifers of the present day. The Gingkos of the Mesozoic age generally had more divided leaves than the *Salisburia* of the Tertiary and present times; but on looking over the entire field, it is impossible to detect any progressive tendency to simplicity or complexity in the foliage of the coniferæ. The cycads, of which the golden age was the Jurassic, have always been characterized by pinnate fronds with often narrow pinnules; but their first development was in the Coal flora in the form of *Cordaites* and *Noeggerathia*, in which the leaves were broader than in most later species.

The monocotyledonous plants, the grasses and palms, the yuccas and pandanus, have, as a general rule, narrow leaves and a parallel nervation, for which no adequate explanation has been offered; while some of the lilies and most of the arums have broad leaves of a totally different structure.

The broad-leaved angiosperms begin in the Cretaceous, and speedily acquire pre-eminence in the vegetation of the globe. We now have the life history of this group pretty well outlined in the elaborate figures and descriptions of the Cretaceous and Tertiary floras, but we look here in vain for any law of development in leaf-forms. Among the earliest plants are the magnolias, remarkable for the simplicity of their leaves, their entire margins, and their camptodrome nervation. With these are oaks, generally with toothed, but only later cut and lobed leaves; willows, with simple leaves like those of the present day; *Liquidambar*, with species in the Cretaceous and Tertiary, having leaves with broader lobes than the living one, and yet not decidedly different; Aralias, with digitate leaves, and *Platanus* and *Sassafras*, with broadly lobed leaves, were conspicuous elements in the earlier angiosperm flora, but they were essentially what their representatives

are at the present day. The facts, which I have observed in my study of fossil plants, compel me to reject any system of evolution as an explanation of the observed diversity in leaf-forms.

January 14, 1884.

SECTION OF GEOLOGY.

The President, J. S. NEWBERRY, in the Chair.

Thirty-two persons were present.

The resignation of Dr. I. I. HIGGINS, as Resident Member, was accepted, and Dr. LOUIS M. CHEESMAN, of Trinity College, Hartford, Conn., was elected a Corresponding Member.

A paper was read by Mr. B. B. CHAMBERLIN, illustrated by a series of specimens, on

FIELD WORK IN LOCAL MINERALOGY.

As our city extends its boundaries, the levelling of rocky elevations, the opening of avenues and railways, and the construction of sewers, afford continued opportunities for the local collector to pursue his investigations and enlarge his store of trophies in this interesting branch of natural history.

The region beyond the Harlem River will now receive more attention than hitherto.

Some of the more noticeable results of the writer's visits to various localities in and about our city, during the past two years, may be stated as follows :

Ripidolite.—This variety of chlorite is abundant at the dolomyte beds in the vicinity of Morrisania, especially at 145th Street and St. Ann's Avenue.

It is concentrated near the surface of the dolomyte, in layers varying in thickness from a half inch to perhaps five inches. The color is generally of a dull blue, and occasionally of an olive green. The body of the deposit is a mass of folia or scales, usually not over half an inch in diameter. The dolomyte immediately adjacent to the deposits of ripidolite is mostly of a friable character and darkish in color, varying from a dull violet to brown.

A new locality for a local mineralogist which has lately attracted my attention is the marble quarry on Jerome Avenue. Here the deposit of the above-named mineral is exhibited in a striking manner. The layers are at times greatly distorted.

Aggregations of the folia occasionally approach crystalline forms—perhaps quite as near as the tender nature of the mineral will allow

under prevailing circumstances. These crystal masses, when scattered over the white dolomyte, afford the collector pleasing contributions to his cabinet, rarely surpassed by any of our local specimens.

The history of this ripidolite formation is worthy of a more complete investigation than it has yet received.

The Jerome Avenue quarry may be announced as a new locality for *Tremolite.*

It is to be hoped the supply may be considerable, as the Kingsbridge locality has long since been abandoned.

After gleaning in the above locality specimens of ripidolite and tremolite, the collector will perhaps add to his stores what fragments of *Quartz* may fall in his way. Most of these display drusy surfaces in yellowish and brownish tints, due to the presence of iron. Others are clear and brilliant, the crystals of a larger size, but showing pyramidal faces only. One specimen, showing an association of *Blende* and *Rutile*, indicates that a keen eye may be used to advantage in future observations, as the work of quarrying progresses.

Associated with the beds of dolomyte in North New York appear masses of *Actinolite* rock, furnishing crystals of considerable merit. The forms are long and slender, in color an olive green. Good terminations are quite abundant.

Within the past year further progress has been made in removing the rock masses at 120th Street and Fourth Avenue. The delicate blue *Tourmalines* (probably the *Indicolite* referred to by Prof. Webster) may occasionally be obtained in limited quantities.

The mineral sometimes appears a mere cloudy spot of sky-blue tint, easily recognized.

Also noticeable at this locality is the *Orthoclase*, of a deep red color, especially brilliant in the vicinity of certain lines of fracture.

The varieties of Mica obtained by the writer in our neighborhood are thus far ten in number.

Among the latest obtained is a *Muscovite*, of decidedly grass green tint, found on Ninety-third Street near Eighth Avenue, also near the Convent on 127th Street west of Eighth Avenue.

At the Jerome Avenue Quarry I found traces of a delicate *brown mica*—peculiar to the dolomyte beds. That found near Morrisania is of a deeper color. Near the latter locality I have secured some interesting finely shaped crystals of muscovite, also fragments of *Biotite.*

Staten Island is noted as one of the chief localities of minerals of the amphibole family. The list has not hitherto embraced *Mountain Leather;* I have the pleasure to report finding specimens during the past summer at the iron mine near Clifton

It may be described as consisting of interlaced fibres of asbestos, the leathery tint due to impurities.

A number of visits have been made to the quarries at Weehawken.

The trap rock of this locality affords specimens of a mineral, the nature of which has not yet been ascertained. It is possibly of a chloritic nature. One is reminded of the investigations of Prof. ISRAEL C. RUSSELL on certain hydro-carbons found by him near Plainfield, N. J., also of the mineral of the Connecticut trap dikes described by G. W. HAWES under the name "Diabantite."

The specimens obtained at Weehawken are light in weight and readily disintegrated. One variety is black in color—resembling asphaltum—the other is of a steel-blue tint.

At the northern extremity of the quarries is found a close-grained trap known as *aphanite*, which exhibits interesting illustrations of radiated structure, and rounded forms with conchoidal fracture, peculiar to concretionary developments of certain minerals.

In the drift overlying the trap I was successful in finding some remarkably good specimens of *Graphite*, much superior to any yet obtained in the vicinity of our city.

DISCUSSION.

Dr. JULIEN remarked that the dark chlorite, however carbonaceous in appearance, owed its color entirely to mineral matter, according to all analyses yet made. It belonged to the group of so-called minerals—delessite, diabantite, etc.—whose want of uniformity in composition and absence of crystallization marked them as transformation products in the alteration of the original augite, etc., of the diabase. The specimens of decayed micaceous mineral exhibited were identical in appearance with Jefferisite, Culsageeite, etc., a series of more or less oxidized forms of an altered chlorite from Pennsylvania and North Carolina, to which a long list of unnecessary new names had been recently given.

Mr. G. F. KUNZ observed that the darker form of chlorite found at Weehawken differed much in appearance from that found elsewhere in the range. Some of it was light green in color, but this was as dark as a hydro-carbon and very brittle, evidently consisting of portions of the rock, thoroughly altered.

Mr. CHAMBERLIN further stated that radiated forms of this chlorite were often seen.

Dr. BRITTON had noticed faults in the rock, at 117th Street and Fifth Avenue, at right angles to the bedding, and lined with a slickensides of chloritic material.

A paper was then read by Dr. JOHN S. NEWBERRY, illustrated by lantern views and a map, on the subject of

THE EROSIVE POWER OF GLACIER-ICE, AND ITS INFLUENCE ON THE TOPOGRAPHY OF NORTH AMERICA.

(Abstract.)

Ice being a comparatively soft substance, seems at first sight incapable of doing much toward the wearing away of solid rock or changing topography. But the facts observed in connection with all glaciers prove that ice is a powerful eroding agent. Where several hundred or several thousand feet in thickness, as some glaciers have been, the ice rests upon the underlying surface with a weight of hundreds and even thousands of pounds to the square foot. Such a mass in motion, impinging against obstacles, has often crushed and removed them, gathering beneath it fragments of all sizes, from sand to boulders ; these have been the instruments of powerful grinding action, which over great surfaces has planed down the rocks, removed or rounded over asperities, filled valleys with debris, and thus produced a marked effect upon the topography. Local glaciers broaden and deepen the valleys in which they move, and having a positive excavating power, have often increased the irregularities of topography ; while broad, continental glaciers have produced just the opposite effect, as we have evidence on a stupendous scale. Over all that portion of North America lying north and east of Bismarck, St. Louis, Cincinnati and New York, the surface bears marks of extensive erosion by ice, consisting of planed, scratched, and undulated rock surfaces, the inscription made by glaciers and nothing else, and sheets of transported material, which has been brought a greater or less distance from the north southward. This sheet of drift material extends from the Banks of Newfoundland, which are formed of glacial debris, over Nova Scotia, Canada, New England, New York, Northern Pennsylvania, over most of Ohio, Indiana, Illinois, Michigan, Wisconsin, and Minnesota. From the British line it extends northward, parallel with the Canadian Highlands, probably to the Arctic Sea. Over all this area, which embraces not less than a million of square miles, the surface of the eroded rocks is covered with a sheet from ten to three hundred feet in thickness, averaging thirty or forty feet of glacial debris, boulder clay, boulders, gravel, sand, etc., all of which have been moved a greater or less distance southward. North and east of the Canadian Highlands, which extend from Labrador to the great Lakes, and then to the Arctic Sea, the country has been but partially explored ; yet it apparently everywhere bears evidence of having been covered with glaciers, and it would

thus seem that in the culmination of the Ice Period, the whole country from Greenland to Bismarck, St. Louis, Cincinnati and New York, was covered with snow-fields and sheets of ice. The ice also seems to have been thick enough to overtop the highest mountains in all this region; hence it pressed upon the underlying rocks with a weight of from 50,000 to 300,000 lbs. to the square foot, and having been also in motion and underlain by sand, gravel, and boulders, during the thousands of years of its continuance, it wore away the surface rocks in places hundreds of feet, and, as it retreated, left behind it the great sheet of debris which it had scraped off and moved southward. In the advent and decline of the Ice Period local glaciers occupied in succession different portions of the glaciated area, and there did their special work in deepening valleys and excavating lake basins. In the far West during the Ice Period, the more elevated portions of the Rocky Mountains, the Wasatch and the Sierra Nevada, were occupied by glaciers as far south as the 36th parallel. North of the Columbia the glaciers reached the sea, and all the Puget Sound region was a basin filled with ice. In Southern Colorado and in California, about the Yosemite, the evidences of glacial action are as striking as anywhere else, and thence northward are almost continuous to Alaska, where great glaciers now exist.

The erosive power of ice has been positively denied by a number of American geologists, Prof. J. P. LESLEY, Prof. J. D. WHITNEY, and others; but the facts cited, as well as others, show that ice is, over the region it occupies, a much more powerful eroding agent than water. The streams which drain glaciers are always turbid from the quantity of sediment they receive, through the grinding action of ice resting on sand and stones.

The streams which drain the glaciers of the Cascade range in Washington Territory—the Cowlitz, Puyallup, White River, etc.—are opaque and milky the year round; while other streams, fed only by rains, are turbid only at intervals when the rains are unusually heavy. In the Alps, all the streams which flow from the glaciers are so white from the sediment they transport that their water is called *Gletscher Milch;* and the opalescence of the lakes into which these streams flow is due to the fine particles ground up by the glaciers and held in suspension. Measurements have been made of the amount of solid material transported by these glacier streams, and it is shown to be much greater than that carried away by mere rain-fed rivers. For example, the stream which drains the Aar glacier carries off daily 280 tons of sediment, and that which drains the Justedal glacier of Norway removes 69,000 cubic metres of rock annually; and these are only partial measurements of the eroding power of two small glaciers.

January 21, 1884.

SECTION OF BIOLOGY.

The President, Dr. J. S. NEWBERRY, in the Chair.

Sixty persons were present.

Mr. G. F. KUNZ exhibited two specimens of corundum from North Carolina—the one a crystal of 13 grammes—the other, weighing 3.15 karats, cut *en cabochon*, probably the most perfect star sapphire ever found in the United States. Both were of a rich light brown color, very compact, and resembled a variety of sapphire from the "Hill of Precious Stones" in Siam.

A paper was then read by Prof. H. L. FAIRCHILD, illustrated with the lantern, on

METHODS OF ANIMAL SELF-DEFENCE.

DISCUSSION.

The PRESIDENT remarked on the character of the dentition in the sabre-toothed cat, *Machairodus*, of which the canines of the upper jaw project seven or eight inches, and were curved, compressed, and sharp-edged. In the Tertiary age such teeth were common to many carnivorous animals not closely related, and seem to have been instruments fitted and employed for reaching the vital parts of other animals especially protected by bony armor. In ancient times, a constant competition had been going on between the means of offence and defence. This was well illustrated by the strife now maintained between the weapons and armor of men and ships in human warfare. Some of the ancient animals were better provided with means for attack and defence than any in later times—for example, the mail-clad ganoids and spine-bearing sharks of the Devonian and Carboniferous seas, the formidable teeth and claws of *Megalosaurus* and *Lælaps*, and the thick bony plates and enormous spines for defence of *Stegosaurus;* also the great canines of *Machairodus*, and the impenetrable carapace of the contemporaneous *Glyptodon*. In the latter case the huge armadillo was probably vulnerable only at the throat, and the sabre-like teeth of *Machairodus* were probably used to penetrate that part.

Geology furnishes many examples of the nice adaptation of means of defence among the herbivorous animals against the weapons of the carnivora, but it is a remarkable fact that we find very few

rudimentary and imperfect organs of this sort. This is one of the many mysteries of the geological record, that the successive steps in the development of means of offence and defence should be so rarely found, and it is one of the difficulties of Darwinism as the theory o the universe. Incomplete organs of offence and defence would often be inoperative and useless, like a bridge which is of no value whatever if it only partly crosses a stream. The horns of a bull can be of little service, till they project from the head and are well progressed on the road to maturity.

In geological history there is recorded a well-marked progress in the character and efficiency of the devices for offence and defence. Taking for example the placoderms of the Devonian for our starting-point, as these are the earliest well known fishes, we find them encased in armor which would bid defiance to all offensive weapons; but it was so much of a load to carry that they must have been inactive and unenterprising animals. In the Carboniferous age the placoderms had given place to the scaled ganoids and sharks, which were less protected by armor but more active. These continued their reign till the middle of the Cretaceous, when the teliosts, like the trout and salmon, took possession of the waters. These latter are but moderately provided with means of offence, and their thin and flexible scales afford little protection against attack; and yet they have practically taken possession of all rivers, lakes, and bays, and far outnumber other fishes in the open sea. By what means these small and light armed troops gained so complete a victory over their armor-clad predecessors, we can only conjecture; but, it is probable, because they possessed greater intelligence and activity, their superior nerve-power being more than an equivalent for the passive protection of spines and bony plates. In the competition for the food supply which has apparently been the chief struggle of life, the quick-witted and quick-moving teliosts would circle around their slower rivals, and, by devouring their food, create a desert in which they starved.

Similar facts may be observed in the history of the changing fashions in regard to offensive weapons and means of defence among animals, including Man. A large number of the Carboniferous sharks were provided with formidable spines; now only a few sharks and the chimæras retain their spines, but these greatly diminished in size, and more ornamental than useful. So, a century ago, every gentleman wore a small sword, which he was only too ready to use. Where this fashion was general it became universal, for an unarmed man, in a crowd who carried arms, was quite at their mercy.

In the middle ages all warriors were clad with mail; but this, to be

an effective defence, was so cumbrous that, if the occupant of one of these steel prisons was so unfortunate as to be thrown on the ground, he could hardly, unaided, recover himself. Now all this system of defence has been abandoned, and celerity of movement and improved weapons have made the light-armed troops of to-day far more effective.

In the competition between the iron-clads and improved projectiles, which has been in progress during the last twenty years, we have a parallel instance of the reciprocal influence of improvements in the means of attack and defence.

Prof. W. P. TROWBRIDGE remarked on the interest of this subject. As an instance, the box-turtle had a perfect protection in his shell, which could only be destroyed by being dashed against a stone. But the very difficulty in such cases had often called out the ingenuity of animals. Crows have been often seen by him in Puget Sound dashing mussels against the rock, by dropping them from a height of twenty or thirty feet.

The immeasurable superiority of Man was shown in his absolute power of overcoming all obstacles by his intelligence. No animal can resist his power and will. This absolute power of Man to provide, both for his defence and for the destruction of the lower animals, renders it difficult to believe in his origin by development from them.

January 28, 1884.

LECTURE EVENING.

The President, Dr. J. S. NEWBERRY, in the Chair.

A large audience was present to listen to the first lecture of the Course of 1884, by Prof. J. W. POWELL, of Washington, D. C., on

THE MYTHOLOGY OF THE INDIANS OF THE SACRAMENTO VALLEY.

At the conclusion of the lecture, on motion by Prof. O. P. HUBBARD, a unanimous vote of thanks was passed to Prof. POWELL.

February 4, 1884.

REGULAR BUSINESS MEETING.

The President, Dr. J. S. NEWBERRY, in the Chair.

Sixty-five persons were present.

Mr. S. LOWELL ELLIOT was elected a Resident Member, and the resignations of Messrs. I. L. CLOSE and THOS. A. CLARKE were accepted.

A paper was read by Dr. J. S. NEWBERRY, illustrated by lantern views and botanical specimens, on

THE BOTANY, GEOLOGY, AND RESOURCES OF THE COUNTRY TRAVERSED BY THE NORTHERN PACIFIC RAILROAD.

February 11, 1884.

The President, Dr. J. S. NEWBERRY, in the Chair.

Forty persons were present.

The following memorial notice of the late Vice-President of the Academy, Dr. BENJAMIN N. MARTIN, was read by the Secretary:

The Committee appointed to prepare a minute, with *Resolutions*, respecting the death of Prof. B. N. Martin, submit the following Report:

BENJAMIN NICHOLAS MARTIN, S.T.D., L.H.D.,

born at Mt. Holly, New Jersey, on October 20, 1816, was graduated from Yale College in the Class of 1837. He made profession of the Christian faith while at College, and entered the theological seminary at New Haven immediately after graduation. After supplying the pulpit of the Carmine Street—now West or Forty-second Street Presbyterian—congregation for nearly two years, he became pastor of the First or Russel Congregational Church of Hadley, Massachusetts, where he remained until 1847. His labors were attended with signal success, and his memory is still cherished by the older families of each congregation. While in New York, he had married Miss LOUISA C. STROBEL. The climate of Hadley proved unsuited to her health, so that in 1847 he resigned his charge. He became pastor in 1848 of the Fourth Presbyterian congregation of Albany, New York, but retained the charge for little more than a year. This was his last regular pastorate.

He remained in Albany during the following three years, devoting himself to general study. During his years of labor as preacher and pastor, he studied earnestly in theology and metaphysics; but, during these years at Albany, his associations gave opportunity to gratify his native bent toward the natural sciences, which he did not fail to improve to the utmost. In 1852, he was called by the University of the City of New York to fill the Chair of Logic and Philosophy, which then covered nearly all branches of mental and political science, with not a little of literature. From that time, until the day of his death,

his name has been prominent in connection with almost every good work. His influence has been felt in all directions. He was an effective worker in the Evangelical Alliance, the American and Foreign Christian Union, the Society for the Prevention of Crime, and the New York Academy of Sciences.

In 1862, Columbia College conferred on him the degree of S.T.D., and, in 1869, the Regents of the University of the State of New York bestowed on him the degree of L.H.D.

Prof. MARTIN'S married life lasted for forty-one years, and has been rightly described as well-nigh ideal. Mrs. MARTIN'S death, in April, 1883, was a terrible blow; but her husband was not of those who sorrow without hope, and his patience while thus stricken was a proof of his Christian fortitude. The separation, however, was short, for on December 26, 1883, he died of acute bronchitis, dying, as he had lived, full of faithful, cheerful trust in his God, whom, with singleness of heart, he had served for full fifty years. The only issue of the marriage was one son, who is still with us, and whose labors in the service of the Academy are second in importance only to those of his father.

Professor MARTIN was a faithful member of this Academy; his services were equally effective and unostentatious. It is no exaggeration to say that the Academy owes very much of its prosperity to his exertions. His quick and generous recognition of merit in the younger members—his kindly words of encouragement, on occasions when keen, and perhaps deserved, criticism was chilling hope, will not be forgotten by some whom he thus kept in the way of study.

Professor MARTIN'S acquirements were remarkable. He began his studies in science when most of the branches, now so important, were in their infancy. With rare power he seized the salient points in each subject, and, with careful, systematic study, he kept himself well abreast with the advances of the succeeding thirty years. He was not an expert in zoology, or geology, or mineralogy, or molecular physics; but he was so well grounded in the general principles of each that no geologist, or zoologist, or mineralogist ever conversed with him for an hour without gaining some new conception, without feeling broadened, without feeling that he had talked with one who had reached the higher planes of philosophy. This breadth of information gave him wonderful power as an instructor in metaphysics—as an instructor in any branch. He was encyclopædic himself; he made his students so also. Other instructors taught their specialties, but Professor MARTIN, in addition to his own work, taught the student to gather all together, to assort the information, and to put away every fact in its own place along with those related to it. So, the thoughtful

student, when done with Professor MARTIN'S immediate instruction. went away a well-furnished man, often surprising his seniors in age and acquirements by his stock of general information, so well assorted and so easily available.

That Professor MARTIN was a great thinker, his published essays prove; that he was a great teacher, more than a thousand pupils affirm; but more than thinker, more than teacher, he was great in those higher attributes which gain for a man not merely the respect, but also the love, of those with whom he is brought into contact. Though knowing no fear of man in his defence of principle, his great heart was overflowing with kindness. Throughout his life, his was a fitting exemplification of the religion which commands—"Do ye unto others as ye would that they should do to you." Like his great Master, he literally went about doing good. When he conferred a favor, he imposed no obligation; he demanded not gratitude, and, therefore, seldom failed to receive it. Wherever good could be done, he was there to do it. He visited the sick in hospitals; he carried sunshine into many a dreary tenement; he lifted the load from many a weary heart. He believed, in his practice, that "pure religion, and undefiled, is to visit the widow and fatherless, and to keep one's self unspotted from the world." J. J. STEVENSON, for the Committee.

REMARKS.

Rev. Dr. E. P. THWING expressed a deep sense of his own personal loss. Dr. MARTIN was a many-sided and well-developed man; a gentleman by birth, by instinct, and by culture. In his early life he took a pulpit in a New England village, not far from Dr. THWING'S birthplace, and became prominent for his useful service. He also had a successful intellectual contest with an older clergyman of that place, a man of great dignity and weight, in which the youthful and the aged athletes were compared to a sword-fish and a whale. The young preacher's mind was clear, incisive, brilliant, and grew with years in strength and moral power. Dr. THWING desired to offer also a father's grateful tribute to the faithfulness of Prof. MARTIN as an instructor and example to his own two sons in the University. Happy indeed was he who taught by his life as well as with his lips. Dr. THWING had been associated with his lamented brother for years as a clergyman, in clerical bodies. To know him was to love him. He expressed profound interest in certain experiments in the science of Psychology. But the work of the scholar, the teacher, and preacher, was suddenly ended. We would drop, however, this garland of amaranth on his fresh grave, in full assurance that his unend-

ing life, his unimpeded activities, go on in higher spheres, and that, some day, we, too, would be with him there.

Prof. J. P. TROWBRIDGE remarked on the universal deep feeling, throughout the ACADEMY, of the loss of Dr. MARTIN. It was almost impossible to give full expression to the general sorrow. He was in all respects a remarkable man, distinguished for his constant interest in the ACADEMY, and for his retiring modesty and ability. The loss was an irreparable one. He seconded the motion proposed.

Mr. E. P. HALLOCK expressed, in behalf of himself and of Prof. CHAS. A. JOY, the former President of the NEW YORK ACADEMY OF SCIENCES, their deep sorrow at the decease of Dr. MARTIN.

The PRESIDENT desired personally to add his tribute of respect and affection to the memory of Dr. MARTIN, and to present his testimony to the great loss his death was to all those attempting to support any educating, elevating effort in the city of New York. These only could understand the difficulty of a struggle, in such a commercial centre, against the over-riding influences which surround them. He had felt, on hearing of this death, that it was an irreparable misfortune, not only to the ACADEMY, but to New York—so long had Dr. MARTIN been engaged in every enterprise connected with good in this city. His life was a precious one. He felt personally the loss of the refined, tender, gentle, and also intellectual influence which Dr. MARTIN had always exerted. No one more fully represented the type of a Christian gentleman. No one in this city had become more endeared to his friends than he, although others might be more publicly known. This was a loss, indeed, in which the feelings were too deep for words.

It was voted to place the memorial on the files of the ACADEMY, and the PRESIDENT then presented, in behalf of the Committee, the following Resolutions, which were read by the Secretary:

Whereas, An inscrutable Providence has removed by death Prof. BENJAMIN N. MARTIN, D.D., First Vice-President of the NEW YORK ACADEMY OF SCIENCES, and one of its most honored, useful, and loved members; as a tribute of respect and affection, the ACADEMY adopts the following Resolutions:

Resolved, That the ACADEMY OF SCIENCES, in common with every good cause and every elevating and philanthropic enterprise in the city of New York, by the death of Dr. MARTIN has suffered an irreparable loss, and has been deprived of a wise counsellor, an efficient worker, an accomplished scholar, a faithful friend, and a Christian gentleman.

Resolved, That, though he has gone from among us, we should be grateful that we were so long permitted to enjoy his society and receive the benefit of his co-operation ; and we have the satisfaction of knowing that the good work he has done and the shining example he has left will be enduring and will constitute a noble and imperishable monument.

Resolved, That, as a permanent record of our sorrow at his death, and as an expression of our esteem and affection, these Resolutions be included in the minutes of the ACADEMY, and published in the Transactions.

These Resolutions were then unanimously adopted.

A paper was then read by Prof. JOHN K. REES, on

THEORIES IN REGARD TO THE CAUSES OF THE RECENT RED SKIES.

DISCUSSION.

Prof. J. P. TROWBRIDGE remarked that the theory of volcanic dust appeared to him to be the most rational of all proposed.

As to the possibility of the distribution of the volcanic dust of the eruption of Krakatoa over so vast a district, he would recall some analogous phenomena. He remembered, some years ago, seeing a few trees on fire in Michigan. Within a few days afterward the forest was in flames over a large territory, and shortly after that there was alarm at Newport, R. I., and other places on the eastern coast, because the atmosphere was rendered so dark by smoke that artificial light was required during the daytime. The smoke had evidently been floated over the intervening area, in some upper stratum of the atmosphere, and descended in certain places.

The spread of the volcanic dust was probably due to the high prevailing atmospheric currents, apparently in great atmospheric curves, which would account for the course of these currents.

He could not assent to the theory of cosmic dust. In that view, the phenomena should have been simultaneous, and not locally different in time.

As to the descent of the volcanic dust, its rapidity would depend upon the diameter and weight of the particles, as well as the force of the upward and downward currents. Thus, in the deposit of the silt of the Mississippi, the upward and downward currents within the

body of the stream tend to keep the particles of silt long in suspension.

Mr. B. B. CHAMBERLIN referred to the lemon-yellow color which frequently succeeded to the red glow, and produced very interesting results, generally rendering the lighter clouds pea-green, and the heavier ones olive. A little later he had noticed that the steam from the steamers in the harbor assumed a beautiful lavender color, while the smoke from the chimneys was colored like the clouds.

The PRESIDENT supported the view that the red glow was due to the diffusion of volcanic dust rather than cosmic matter, and gave several illustrations of the abundance of particles of solid substance in the atmosphere. Smoke, which consists of minute particles of carbon, sometimes covers whole States, and obscures the sun's light. During the last summer he had traversed a great area on the Pacific coast, where, for several months, smoke from forest fires in a specially dry season had concealed all distant objects. The blue color of the sky is supposed to be due to floating particles, and the haze which prevails for days and weeks with a cloudless sky, in autumn, is nothing but dust and smoke. The accumulation of volcanic dust on ships at sea, hundreds of miles from the craters from which it had issued, is an exhibition of the possible wide diffusion of such material.

The system of circulation of the atmosphere favors the spread over the whole world of dust thrown into the air in the tropics. The movement of the surface from west to east in the rotation of the globe is about one thousand miles an hour. The atmosphere, resting on the earth, moves with it, but not quite so fast. It lags behind at the surface five or six miles an hour ; at a greater elevation, perhaps much more. This causes the great equatorial wind current, which flows from east to west in a belt, some thirty degrees in width, along the equator. At the same time the air in the equatorial belt is heated, rarified, and rises, to be replaced by the cooler northeast and southeast trade-winds which blow in along the surface of the sea. This causes a great movement of the atmosphere from the equator in a series of vertical circles toward the poles. As a consequence of this system of atmospheric circulation, whenever a discharge of dust takes place from a volcano like Krakatoa, in the equatorial belt, the dust is, in the first place, carried upward in the ascending currents of the heated zone, is carried westward by the equatorial current, and distributed toward the poles by the outflow from that zone. Hence, it is easy to see that the dust of Krakatoa might in time pervade the atmosphere over all the earth's surface.

February 18, 1884.

The President, Dr. J. S. NEWBERRY, in the Chair.

Twenty-three persons were present.

The resignation of Mr. CHARLES H. TRASK as Resident Member was received and accepted.

There were exhibited by Mr. G. F. KUNZ, two images, the *Llama* and *Vicuña*, from the interior of Peru.

They weighed six ounces each and were both of solid silver, with the exception of the bodies, which were filled with some earthy material. The *Llama* had evidently been acted upon by substances in the soil which left the silver in a remarkably pure state, and the workmanship on this figure, especially the hair reproduction, was very fine.

The *Vicuña* was not of as pure silver, and was in a very good state of preservation.

Mr. KUNZ explained that a famine in the interior of the country had caused the graves to be despoiled of many thousand ounces of ornaments, which were carried to the seacoast and there sold for their weight in silver and gold.

In speaking of the lapidary work done in agate, jade, and chalcedony at Oberstein and Idar in Germany, many articles made and sold there were described, and some perforated carnelian ornaments were exhibited, in which the perforations were round at one end and over one inch across, ran to an acute point, and varied in length from 2½ to 4 inches. They are sent to the interior of Africa, and sold at from four to five cents each, and are there worn by the natives.

A jade pendant was shown, over 1½ inch long, being one of a lot of over 200 lbs. of jade made up and sent to New Zealand. Mention was made of a mass weighing nearly 300 lbs., to be used for the same purpose. The cost of making these ornaments at Oberstein was about 40 cents each, which was much less than they could have been made for by native or skilled New Zealand labor.

There was also exhibited an oval carnelian disc, that had been shaped for cutting by chipping with a small hammer ; this chipping is equal to any that can be seen on American stone antiquities, and the entire cost perhaps one cent.

Some onyx beads were also shown, that in London or Ceylon would bring from £10 to £20 sterling per string, and were here made for as many dollars.

Mention was made of an American who achievêd a fortune by importing the *Elephantum dentalium* from the Red Sea and selling it to our American Indians.

These instances illustrated the far-reaching influences of modern commerce in the most remote regions of the earth, and also the increasing difficulty in determining the genuine character of supposed aboriginal work in jade, chalcedony, etc.

The PRESIDENT regretted that the history of the silver images exhibited by Mr. KUNZ was not known, as they were probably of considerable antiquity.

They were imitations of two species of South American animals, one the *Llama*, the other the *Vicuña*; the fibre of the wool was very truthfully represented, and great freedom and variety were shown in the general work. Dr. F. N. OTIS formerly had some silver images of great interest brought from Peru, and now in the Blackmore Museum at Salisbury, England, to which he had presented them. In Colombia and on the Isthmus, Chiriqui, etc., the natives had made articles of a similar kind. Señor URICOCHEA, a gentleman who lived many years at Santa Fé de Bogota, had told him that a class of professional gravediggers and treasure-hunters existed there, who employed gangs of Indians in their work, and he had seen twenty-five pounds of gold images melted up to pay these employees. Some of the articles from Chiriqui had been treated by a process of pickling, the alloy of gold and silver having been digested in a solution and afterward polished.

As to the arrow-heads, there are still some tribes of Indians at the West who chip their arrow-points.

In Oregon he had formerly visited tribes who were armed only with beautiful bows and arrows, the shafts being constructed of reeds and the points of obsidian. The latter were very slender, so that they were broken and destroyed by a single use. Gen. FREMONT had obtained some beautiful examples of these, and had two of them made to be worn as ear-pendants by his wife. These were made without a blow, being chipped by crimping the obsidian against a piece of soft material, either metal or wood, held in the hand. Little force, but much skill and experience, were required in this manufacture.

The PRESIDENT exhibited a beautiful specimen of grouped crystals of argentite, from the Batopilas mine, Mexico.

Mr. KUNZ stated, in regard to the silver images, that, two years ago, five thousand dollars worth of such articles, made of gold and silver, were melted up at a refinery in this city.

Dr. A. A. JULIEN reported the results of his microscopic examination of the volcanic ash of Krakatoa, from a specimen fallen upon the deck of a vessel off the coast during that eruption. The material is almost entirely angular, only a few of the larger grains showing such slight rounding of angles as might have been produced by mu-

tual attrition. During their short period of aërial transport, there seems to have been little contact between the particles of this ash. It appears wholly made up of a colorless obsidian, showing the usual optical behavior of a glass, with the exception of occasional pale lines of refraction. These are due to an almost universal fibrous structure, or penetration of an amorphous glassy groundmass by fine parallel lines. The fracture has been strongly influenced by this structure, so that many particles have linear forms, which, in association with their fibrous structure, make them resemble in ordinary light the grains of some mineral with strong cleavage. About one-third of the ash consists of minute particles, not exceeding a few thousandths of a millimetre in diameter. The measurements of the diameters of the particles of the greater portion, *i.e.*, about two-thirds of this ash, are given (A) in the table below, in fractions of a millimetre. For the sake of comparison, there are also given (B) the measurements of the fine reddish angular sand of the Sahara, consisting almost entirely of glassy, milky, and reddish quartz, and a little chalcedony and chert, and (C and D) of two samples of a fine dust, evidently derived from the Sahara, which fell a half century ago upon the deck of a vessel, fifty miles off the coast of Africa. The sample C consists of round grains, largely cellular, composed of glassy and milky quartz and of chert, chalcedony, and foraminifera. The sample D was mostly made up of angular particles of glassy and milky quartz, chert, and chalcedony, intermixed with coarser rounded grains of the same.

	Range.	Average.
A. Gray ash of Krakatoa, greater portion.	0.01 —0.09	Less than 0.03
B. Fine red sand of the Sahara.....	0.075—0.30	0.075—0.125
C. Coarse dust from vessel's deck.....	0.20 —0.74	0.25 —0.36
D. Fine dust from vessel's deck.....	0.07 —0.35	0.10 —0.18

It will be seen that the particles of the Sahara sand are, on an average, from two to four times as large as those of the ash of Krakatoa, but that those of the dust C are from eight to twelve times as large, and those of the dust D, from three to six times as large. As the specific gravity of obsidian (2.3 to 2.5) is decidedly less than that of quartz (2.5 to 2.8), it would not be astonishing that the exceedingly fine particles of the ash should have suffered a vastly wider transport.

The PRESIDENT observed that he had recently heard much said on the subject of the origin of the "red skies," in opposition to the supposed absurdity of so wide a transport of the ash of Krakatoa, but there was no other known source of such pulverulent matter, and there could be no doubt that the volcanic ashes might be transported any distance. The known system of atmospheric circulation would

favor it. It would not fall, because it would have to stem an opposing current. Prof. LOOMIS has pointed out the existence of a dry belt on either side of the equator, and the need of air from the tropics, coming over the water, *e.g.*, the Gulf of Mexico, and so coming northward, loaded with moisture, to be here deposited as rain. Thus anything thrown into the atmosphere in the region of ascending currents could be readily carried up.

Mr. F. COLLINGWOOD exhibited a sample of curiously corroded iron wire. He had been called upon to examine the cables of the Suspension bridge at Pittsburg, built about twenty-four years ago by the elder ROEBLING, and to superintend the repairs. The cables, where they enter the anchorage, were enclosed in heavy canvas, filled solidly with coal-tar which had been boiled and treated with quick-lime. A brick wall was then built on each side of each cable, and the whole space between these and around the mass of wire and coal-tar was filled with cement mortar. Over this was a layer of heavy flag-stones laid in cement, and over this the flags of the side-walk. In some way, in the lapse of time, a considerable portion of the tar at each cable end had disappeared, and the cavity thus left contained in every case a dirty brown liquid, in *some* cases nearly filling the cavity. The mystery was whence the liquid came. One theory was that the coal-tar had undergone a slow distillation by the heat of the sun, striking on the flagging above. The liquor contained various salts of ammonia, among them the sulphide being quite prominent. His own idea was, that the high temperature acquired during a hot day would make the tar very liquid, and it would then (as was found) penetrate the brickwork and leave a cavity.

This cavity would be filled with air, which, at the high temperature of a summer's day, would be expanded and a portion forced out. This would be pumped in again by the cooling down which takes place at night ; and, when the air was highly charged with moisture, a part of this would be condensed and remain in the cavity.

This would account also for the sulphur, which is no doubt diffused in sensible amounts in the atmosphere of Pittsburg from the large coa consumption. The wire seizings were $\frac{32}{1000}$ of an inch in diameter, an were in many places rusted through. There were several wires rusted off in each cable. Nearly all the exterior wires in each strand were corroded somewhat, and it was thought best to cut and repair about 500 of them. The masonry was cut out, and tunnels built so as to afford ready access to each cable in the future. The cables were unwrapped for about 15 feet outside of the masonry and every wire thoroughly cleaned. In every case, before putting on the wrapping again, the cables were saturated with boiled oil and white lead.

Where the strands separate on entering the anchorages they were completely enclosed in paraffine, as it would hereafter be difficult to paint them at those points.

As to the ways in which the wires were attacked, they were three: First: As if acted upon by an acid, showing clearly the so-called "fibre" of the wire. Second: A roundish, black-looking lump of hard scale would be found, which, when knocked off, would leave a deep pit in the wire. This scale was largely composed of sulphur, and resembled a sulphide of iron. Third: In a few cases the "skin" of the wire was corroded through in a narrow slit, and then the whole interior eaten out, much like the decay of wood at the heart. This was not often seen, but might easily have been overlooked.

Professor W. P. TROWBRIDGE inquired whether the wire had been examined at any portion of the catenary, and also whether there was anything known in reference to the lifetime of the bridge; and suggested that a single wire broken or rusted would make a weak point in the cable.

Mr. COLLINGWOOD replied that the damage to the wires did not extend more than two feet from the anchorages in any case. The cables had been examined at the points where they passed over the towers, and at several intermediate points, and (with the exception of damage to the wrappings, which was easily repaired) the *wires*, on which the strength of the bridge depends, were intact. Experiments for tensile strength and stretch were made on both old and new wire, using an accurate gauge, registering to the $\frac{1}{10000}$ of a foot, and the stretch, reduction of area at point of rupture, and strength were practically identical. The paint was found defective at many points on the cables, and, to insure a perfect covering, the old paint was shaved off and two heavy coats of new put on. There is no reason why the bridge should not last a thousand years, if properly cared for in the future.

The PRESIDENT remarked that the atmosphere in Pittsburg was charged with sulphuric acid, and that this acid-water was certain to make its way into the cable through any crevice, and soon destroy the iron. No mere decomposition of any hydrocarbon could yield so large a quantity of water as that found. The dark product of the decomposition of the wire was probably the simple sulphide of iron.

The subject was further discussed by Professor TROWBRIDGE.

The PRESIDENT announced the death of Professor ARNOLD GUYOT on February 8th, and briefly sketched his character and the principal incidents of his life. He was born in Neufchatel, in

1807; educated at Neufchatel, Stuttgart, Carlsruhe, and Berlin; graduated in 1835, and studied theology; spent the years 1835 and 1839 in Paris; was Professor of History and Physical Geography at Neufchatel from 1839 to 1848. In common with his associates AGASSIZ and DESOR, he entered earnestly upon the study of the Alpine glaciers, when the fact of their former great extent was made known by CHARPENTIER. He took, as his special duty, the study of the distribution of Alpine boulders and the former reach of the glaciers. This study was continued during seven years, and the results were embodied in a large detailed map, which, unfortunately, has never been published. The publication of the observations of AGASSIZ, GUYOT, and DESOR was begun in the "Système Glaciére." Only one volume was printed. In 1848, GUYOT came to the United States, and, in 1849, published a volume with the title "Earth and Man," which was an abstract of a course of lectures delivered by him in Boston, in the French language, and translated by Professor FELTON.

He was then employed by the State of Massachusetts and the Smithsonian Institution, to organize a system of meteorological observations and publish a manual of directions for observers, in 1850. In 1851, he published a volume of meteorological and physical tables. In 1855, he was appointed Professor of Geology and Physical Geography at Princeton, where he remained until his death. During his vacations he studied the structure of the Alleghanies from Maine to Georgia, publishing a summary of his observations in the *American Journal of Science* for 1861. Between 1866 and 1875, he published a series of school geographies and maps, for which a medal was awarded at the Vienna Exposition in 1873. The personal character of Professor GUYOT was singularly pure and sweet. He was not only respected, but loved, by all his students and associates, and a large circle of scientific friends. He probably had not an enemy in the world. He was remarkably methodical and industrious in his habits, had a clear and logical mind, and every year made some important contribution to the stock of useful knowledge possessed by man. No just estimate of the value of his scientific work can be given in few words. He is, perhaps, more widely known by his connection with the study of the Alpine glaciers, which resulted in the discovery of an Ice period in the world's history.

Only a small part of his work on this subject has been given to the public over his own name; but the contributions which he made to the general result attained by the Swiss geologists were no less important than those of any other, and he deserves an equal share of the honor which belongs to so grand a work.

February 25, 1884.

ANNUAL MEETING.

The President, Dr. J. S. NEWBERRY, in the Chair.

Twenty-five persons present.

The Secretary read the minutes of the last Annual Meeting, which were, on motion, approved.

The Recording Secretary, Prof. O. P. HUBBARD, reported that there have been held nine meetings of the Council and thirty-two of the Academy. The attendance on the regular meetings and lectures has been fully kept up. The communications to the Academy were 73, 36 oral, 37 written, and fully illustrated by specimens, lantern views, etc. They might be classed as follows: Arts, 1; Archæology, 2; Chemistry, 11; Biology, 1; Engineering, 1; Geology, 15; Mineralogy, 26; Mining, 2; Natural History, 8; Physics, 6. A full course of public lectures was delivered. The roll of Resident Members has been changed by the resignation of eleven, the death of six, and the addition of only one.

The Corresponding Secretary, Prof. ALBERT R. LEEDS, reported that, in addition to answers sent to various letters of inquiry, he had notified eleven persons of their election as Corresponding Members—this being the total number elected during the year 1883—and had received letters of grateful acknowledgment from these gentlemen, and had duly presented their letters to the Academy. Also, that the vacancy created in the list of Honorary Members by the death of Prof. FRIEDRICH WÖHLER had been filled by the election of Prof. MICHEL EUGÉNE CHEVREUL.

The following Report of the Treasurer, Dr. JOHN H. HINTON, was then read:

NEW YORK ACADEMY OF SCIENCES *in account with* JOHN H. HINTON, *Treas.*,
FROM February 21, 1883, to February 25, 1884.

Dr. *Disbursements.*		Cr. *Receipts.*	
To George Gregory, Printer	$737 80	Balance from February 21, 1883	$20 06
" Spectator Co., Printers	444 66	From Annual dues	1,315 00
" Lecture Committee, for lectures	112 70	" Subscriptions to Annals by members	252 00
" Prof. D. S. Martin, for editing Annals,	100 00	" Sales of Annals by Prof. D. S. Martin	19 82
" Academy of Medicine, one quarter's rent	106 25	" Initiation fee of one member	5 00
" Miss L. R. Weeks, from Oct. 1, 1882, to June 1, 1883, addressing wrappers, etc	77 04	" Interest on U. S. Bonds	164 00
" A. Woodward, work in Library	41 94	" Samuel Sloan, Esq., to become a Patron	100 00
" Prof. D. S. Martin, express, postage, etc., etc	64 55	" Mrs. Esther Herman to Publication fund	25 00
" Prof. O. P. Hubbard, express, postage, etc	5 26	" Prof. A. R. Leeds to Publication fund	25 00
" Temporary investment of Samuel Sloan's Patron Fund in a Chesapeake and Ohio B. Bond	98 12		$1,925 88
" John Cornelius, for collecting $1,253	125 30	Due Treasurer	7 74
" John H. Hinton, Treas., postage, etc.	20 00		$1,933 62
	$1,933 62		

JOHN H. HINTON,
Treasurer.

The Treasurer explained the large cost of obtaining the annual dues of members, by means of the paid collector, and on motion it was

Resolved, To send a notice to the members, urging prompt payment.

The Librarian, Dr. A. A. JULIEN, reported that he had received on his appointment, January 7, 127 books and pamphlets, the accumulated accessions. Since that time, 114 parts have been received, amounting to 241 up to date, all of which have been numbered, their titles recorded in the Accession Catalogue, and exhibited before the Academy. The entire Library is in good condition and order, and now amounts to about 7,000 volumes and parts. Of these, about 1,400 volumes and parts now remain unbound, and the sum of fifteen hundred dollars is urgently needed for this purpose. An annual appropriation of five hundred dollars is required for the binding of the accessions of each year, and would insure the preservation of valuable works from injury by handling.

The report of the Publication Committee was given by the Chairman, Prof. D. S. MARTIN.

The last two numbers of Vol. I. of the Annals have been issued since the last annual meeting; the Index of Vol. II. was published last summer; the first and second numbers of Vol. III. were distributed last fall, and the third and fourth numbers of that volume will be issued during the coming spring. The delay has been due to the lack of papers offered in the summer, and to difficulties connected with the correction of the proofs. Vol. II. of the Transactions and the Indices of Vols. I. and II. have been published.

The election of the officers of the Academy for the coming year then took place, and the following persons were elected:

President—J. S. NEWBERRY.

First Vice-President—D. S. MARTIN.

Second Vice-President—A. C. POST.

Corresponding Secretary—A. R. LEEDS.

Recording Secretary—O. P. HUBBARD.

Treasurer—J. H. HINTON.

Librarian—A. A. JULIEN.

Councillors—G. N. LAWRENCE, LOUIS ELSBERG, E. C. H. DAY, W. P. TROWBRIDGE, H. L. FAIRCHILD, C. VAN BRUNT.

Curators—B. G. AMEND, C. F. COX, B. B. CHAMBERLIN, N. L. BRITTON, A. H. ELLIOTT.

Finance Committee — T. B. CODDINGTON, PHILIP SCHUYLER, THOMAS EGLESTON.

The PRESIDENT then made remarks upon the condition of the Academy, its library, etc.

He then presented an appeal, received from a committee headed by Prof. ALPHEUS HYATT, of Boston, in favor of the erection of a monument to BARRANDE, as a testimony to the remarkable palæontological work accomplished by him, while the nominal secretary and intimate friend of the late Count de Chambord. He was a favorite of fortune above most scientific men, distinguished for his industry and thoroughness, and has already erected a splendid monument to himself in his published works. He has given us a library of palæozoic life, and he deserved everything said in his praise for his perseverance, industry, and even genius, and was entitled to any further memorial which scientific men should see fit to raise. Still, it was true that many other able men, like GUYOT, without such advantages, have done a vast amount of useful work which often remains unpublished. It was unfortunate that no memorial was possible for such a man as GUYOT, though the best monument would be the publication of his great map of the ancient Swiss glaciers and the accompanying description of his labors in that field.

March 3, 1884.

REGULAR BUSINESS MEETING AND LECTURE EVENING.

The President, Dr. J. S. NEWBERRY, in the Chair.

The large East Lecture Room was well filled by the audience.

Mr. B. EDSALL and Dr. S. S. FRIEDRICH were elected Resident Members.

The following *Resolution* was passed :

"That all the meetings of the Academy shall be advertised in two public journals until the summer adjournment."

Prof. D. S. MARTIN read by title a paper by Mr. W. G. BINNEY :

III. NOTES ON THE JAW AND LINGUAL DENTITION OF PULMONATE MOLLUSCS.

The PRESIDENT then introduced Prof. D. CADY EATON, of New Haven, Conn., who gave a lecture, illustrated by lantern views, on

CHRISTIAN ICONOGRAPHY, AS ILLUSTRATED IN THE CATHEDRALS OF THE MIDDLE AGES.

On motion, the thanks of the Academy were presented to Professor EATON.

March 10, 1884.

SECTION OF PHYSICS.

The President, Dr. J. S. NEWBERRY, in the Chair.

Sixty persons were present.

An invitation was received to send a delegate to the third annual meeting of the ROYAL SOCIETY OF CANADA.

Letters of resignation from Messrs. C. F. IMBRIE, W. LE CONTE STEVENS and J. K. FUNK were read and accepted, and Mr. JOHN G. BRANNER, of Scranton, Penn., a geologist to the Pennsylvania Geological Survey, was elected a Corresponding Member.

Mr. G. F. KUNZ exhibited some very small crystals of quartz, found in the Bear River region, Idaho, and Fort Defiance, Arizona, where thousands of miners are looking for diamonds. These crystals of quartz resemble those of that mineral, from their rounded and, apparently, octahedral form, which is due partly to the mode of crystallization, the two sets of pyramidal planes of the terminations closely approaching each other, and partly to abrasion by rolling in streams.

The PRESIDENT had found quartz crystals of the same form in the Shell Creek range, in Eastern Nevada, scattered in thousands through a trachytic rock, as well as in a similar rock of the Black Hills. He had examined the material washed from the sands of Upper California in search for platinum. In this a diamond of the weight of five-eighths of a karat had been found, and one even larger.

A paper was then read by H. CARRINGTON BOLTON, Ph.D., of Trinity College, Hartford, illustrated by a series of specimens, on

RECENT VISITS TO "SINGING BEACHES" IN SCOTLAND AND AMERICA.

[Abstract.]

The speaker stated that, since the paper by his co-worker, Dr. ALEXIS A. JULIEN, on the "Singing Beach of Manchester, Mass.," had been read before the Academy, he had continued his investigations, and

proposed now to give an informal personal narrative of his experience in search of "singing beaches," with some of the results.

His attention was first directed to the curious natural phenomenon known as "musical sand," at a casual visit to Manchester-by-the-Sea, in August, 1882. On making inquiries of distinguished naturalists and geologists at home and abroad, both in person and by letter, and by a long search in State Geological Reports, without result, he found that the phenomenon had been generally overlooked, though it seemed to him worthy of study. He has since that date travelled many thousands of miles and written scores of letters in search of "singing beaches."

The peculiar squeaking sound made by walking over the dry sand at the Manchester beach has been already described in these pages. Tingling sensations in the toes and fingers, when kicking or stroking the sand, are also noticeable. The acoustic property of the sand is best demonstrated by rubbing between the hands a double handful, which then gives out three or four (perhaps, five) musical notes on a rising scale. The sounds can be heard over one hundred feet. When the sand is removed from the beach it often loses its acoustic properties.

In July, 1883, the speaker visited Eigg, a small island of the Hebrides group, on which occurs a wonderful "singing beach," discovered by Hugh Miller about 1850. Eigg is an interesting island from an historical point of view, having been the scene of a terrible massacre in the sixteenth century; it is also most interesting to a geologist on account of its lofty peak of pitchstone and other features. The beach itself is about 1,200 feet long, and all the sand possesses marked acoustic properties. The neighboring rocks are Oolitic sandstone. On the mainland, nearly opposite Eigg, at Ardnish, another locality of sonorous sand occurs, which, however, the speaker did not visit.

The next singing beach examined by Dr. BOLTON was on Lake Champlain, near Plattsburg, N. Y., for the clue to which he is indebted to Prof. ALBERT R. LEEDS. At this locality the sand possesses the acoustic properties to a moderate degree; at least the sounds were not so loud as at Eigg, but this may have been due to the damp weather which prevailed about the time of his visit. A notice of this locality was published in *Science*, for November 30, 1883.

Two localities of singing sand were visited by the speaker on Chesapeake Bay, one about ten miles from Norfolk, Va., and the other near Fortress Monroe. Again the damp weather was unfavorable, and only small areas of sonorous sand were found at the first locality, and none at the second, though it has been reported as occurring there in

the summer season. On Chesapeake Bay the areas of sand having sonorous properties occur in the midst of ordinary sand beaches of great extent, and, since the eye cannot distinguish the sonorous from the non-sonorous sand, the existence of the former is hardly recognized, save by local fishermen and natives of the region.

The experience gained on the visits to these five beaches led Dr. BOLTON to believe that sonorous sand is far more common than supposed; so he called to his assistance the services of Mr. S. I. KIMBALL, Superintendent of the U. S. Life Saving Service, who kindly sent out in his own name a circular, prepared by Dr. BOLTON, addressed to the 200 keepers of Life Saving Stations in the United States. From these keepers letters and samples are now frequently arriving. Already forty-six (46) localities of sonorous sand have been reported, at various points on the Atlantic coast, from Maine to North Carolina, and on Lake Michigan. The speaker stated he had a list of 66 localities in all, including foreign.

In conclusion, Dr. BOLTON said he had not attempted to include in his remarks accounts of many foreign localities on his lists, and that he hoped on some future occasion to give the Academy particulars of the remarkable hills in Arabia Petræa and in Afghanistan, already alluded to in a previous communication. The microscopic examination of the samples of sand collected not being as yet completed, he is unable to advance as yet any satisfactory theory as to the causes of the singular phenomenon he has attempted to describe. Since the acoustic properties are not confined to any particular variety of sand (calcareous, quartzitic, and feldspathic sands alike are sonorous), the problem is a difficult one. It is possible that different causes are in operation at different localities. Information as to new localities, and samples of sand, are earnestly desired by the author of the paper and by his co-laborer on the subject, Dr. ALEXIS A. JULIEN.

During his remarks, Dr. BOLTON opened a jar of the sonorous sand which he had collected at Manchester-by-the-Sea on September 5, 1883, and which had remained tightly closed since that date. On rubbing this sand briskly between the palms of his hands, a sound was elicited which was distinctly audible to all in the audience. This experiment established the fact that the sand will preserve its acoustic properties when hermetically sealed.

DISCUSSION.

Dr. A. A. JULIEN reported provisionally on his microscopic examination of the sonorous sands. As to the materials of which they are

composed, they may be the following : limestone and recent corals, as in the Sandwich Islands ; nearly pure quartz, as on Lake Champlain ; quartz, with some feldspar, as at Manchester, Mass. ; quartz, with a little iron-ore and garnet, as on the shores of Lake Michigan and along our Atlantic coast, south of New England ; and quartz with a small intermixture of chert, as in the Hebrides. The form of the grains may be largely angular or tabular, as at Manchester ; more or less rounded, as at nearly all the localities mentioned ; or even nearly spherical or oolitic, as on Lake Champlain. The texture may be cellular, in part, as in the Sandwich Islands and the Hebrides, but is in most cases compact and solid.

Sounds ordinarily heard in nature may originate in animate agents —animals and plants—or in inanimate objects. In the latter, the agencies which produce sounds may be classified as physical, *e.g.*, the rending of rocks or ice by frost ; electrical, *e.g.*, the lightning ; chemical, *e.g.*, the decomposition and explosion of pyrites ; mechanical, *e.g.*, movements in bodies of air, *i.e.*, the winds, or movements in water, the waves and surf ; and volcanic action. There are also sounds of greater rarity which are produced in mineral matter, such as by falling blocks of rock, the flowing of lava-streams, and the special subject under discussion, the motion of loose sands by the winds, waves, or animate agents. The louder and common sounds in nature thus originate in a variety of causes, and it seems probable that more than one condition is concerned in the modification of those heard in the sonorous sands. Various modes of vibration may be produced by the grating of cleavage planes, as in the Manchester sands, or the slipping of curved polished surfaces, as in many other instances ; but the reverberation within minute cavities may be also involved in the peculiar and louder sounds which have been heard in the sands of Kauai and Eigg, which contain cellular grains, and the same may be found true in the similar sands of Arabia and Nevada.

Prof. H. L. FAIRCHILD inquired whether a loss of the sound occurred on the removal of the Manchester sand from that locality, and whether the power of emitting the sound was retained by the sand in a dry room.

Dr. BOLTON stated that he had found that the sonorous sand of Eigg had lost its peculiar property when carried a few weeks in a cloth bag. He had baked the sand of Manchester in an oven, but found that it did not then regain its sonorous character.

[Dr. BOLTON here tested again the sample of sand from Manchester, which had emitted the sound a half hour before and had been since lying exposed to the dry air of the warm room, but the sand now refused to emit any sounds whatever.]

Mr. CHAMBERLIN suggested that such sand might emit louder sounds by its fall from a height.

A VISITOR stated that he had lived eleven months on the shore of Costa Rica, on the Caribbean Sea, about seventeen miles south of Greytown, in longitude 86°, while engaged in laying out a railroad, in the year 1864. He was the only European at that locality. While lying in bed at about eleven o'clock, one evening in February of that year, he was very much surprised by a peculiar sound from the solitary sea-beach outside of the house, which resembled the footsteps of a person approaching. Wondering whether it was caused by some native, or by an animal, such as an alligator, he rose, took his machete, and went out. The sound had ceased, the full moon was shining upon the beach, but no person or cause of the sound could be observed. The following night, at about the same hour, curious sounds again arose outside, sometimes like a low roar or like the barking of a dog, and which seemed to come from the distance of about fifteen yards, near the water-line. He went out and shouted, searching in vain for the workmen who had broken the rules by leaving their huts. On his return to the house, the barking sound was repeated, sometimes resembling the voices of two men conversing, and he thought himself possibly under the influence of some auditory delusion. The following night, a sound broke forth like that of hundreds of loud voices in the air, sometimes like that of singing, sometimes like the stringing of chords. Looking afterward for an explanation of these sounds, he found that the sand of the beach overlaid a stratum of massive coral reefs. At this point a tongue of land jutted far out from the coast-line, and, when the water retired at low tide, he could walk out a considerable distance upon these reefs. He found the whole beach and this coral stratum to be fissured all around the promontory by very deep clefts, and then concluded that the slapping of the water against the rocks, in the hollows beneath the beach, had probably caused these sounds of rushing, barking of a dog, the stringing of instruments, and the sounds of voices in the air. At present, he questioned whether a sonorous variety of sand might not also have been involved in this curious phenomenon.

March 17 1884.

SECTION OF GEOLOGY.

The President, Dr. J. S. NEWBERRY, in the Chair.

Thirty-four persons present.

Dr. N. L. BRITTON made some remarks, illustrated by a series of specimens, on the subject of

OBSERVATIONS ON THE GEOLOGY OF THE VICINITY OF GOLDEN, COLORADO.

DISCUSSION.

The PRESIDENT referred to the immense collection of the fossil plants which had been made at Golden, by Prof. LAKES, and purchased for the museum at Cambridge, Mass. Many of the plants, chiefly of the upper series and Tertiary age, have been studied by LESQUEREUX, who has published a large volume on the subject. Nevertheless, all these studies have covered only the beginning of the extensive flora which is represented at this locality. Palms must have abounded there in great numbers, variety, and large size, the country having once been overgrown by a vast forest of these trees. There were also other trees, some yet to be identified, *e. g.*, one unknown conifer, of which a trunk, twelve feet in diameter, is now standing at Florissant, in the vicinity of Golden.

Dr. JOHN S. NEWBERRY then presented, with lantern illustrations,

NOTES ON A VISIT TO SOME OF THE SNOW-PEAKS OF OREGON.

March 24, 1884.

The President, Dr. J. S. NEWBERRY, in the Chair.

Eighty-five persons present.

Mr. G. F. KUNZ stated that while unpacking some specimens of fluorite from Amelia County, Va., he had noticed the display of phosphorescence, a pale greenish light, by the mutual attrition of the specimens, the same being excited also by the warmth of the hands; by the heat of a candle this phosphorescence was increased, and on a red-hot stove became a deep emerald green. A specimen that phosphoresced in warm water was also shown. In Phillips' "Mineralogy," edition of 1823, a specimen of fluorite is mentioned, which yielded light by the warmth of the hand. He had since examined fluorite from over a dozen localities and had found that only chlorophane yielded phosphorescent light by attrition.

The attrition causing phosphorescence, Mr. KUNZ said, was new, and as the same result was produced by chlorophane from Branchville, Ct., it was said to be a new distinguishing characteristic be-

tween chlorophane and common fluorite, as in the case of pectolite from Bergen Hill, distinguishing it from the fibrous zeolites and other associated minerals.

A paper was then read by Mr. F. COPE WHITEHOUSE, M.A., with lantern illustrations, entitled :

The Topography of Egypt between 28° and 30° N. L., from original surveys made in 1882 and 1883, with special reference to the erosions—200 feet—of the Qerun and Reian Basins, and the two natural eminences (+650), to the west of the Kom El-Kashab (+950), of the same height as the summits of the pyramids of Gizeh.

[Abstract.]

On March 3, 1882, I went into the desert about fifty miles west of the Nile Valley and seventy-five miles southwest of Cairo, to examine the neighborhood of a hill, hitherto unvisited, known to the Arabs as the Haram. "Haram" is "Pyramid." This hill is not a pyramid nor is it pyramidal in appearance, although the buttes of horizontal limestone commonly assume a conical form. Nor is there any pyramid in Egypt (with one insignificant exception) to the south of the point where the Bahr Jousuf, which branches from the Nile at Siut, turns into that Western Oasis which has been identified with Pithom and the land of Goshen. Being without any European servant or companion, I could only satisfy myself that this hill of limestone streaked with gypsum was in a valley considerably below the level of the Nile. On April 4, I visited the Eastern part, and Mr. FLINDERS PETRIE, who accompanied me, assured me that it was not less than 250 feet below the level of the Nile, or about 180 feet below the Mediterranean. If filled with water, it would have the shape shown on the accompanying maps. This valley is not marked on any map prior to my autograph map, published in the June Proceedings of the Society of Biblical Archæology (1882). My belief in its existence was due to the ancient records of a Lake Mœris containing a pyramid-island, and a *mu amenti nti mar*, "the water of the lake of the West," with a canal ascribed by tradition to the patriarch Joseph or to a King Mēn. The lake or *Birket* marked on the map in the northern half of the same depression is stated in the books as about the level of the Mediterranean. On March 12, 1883, I ran a line of levels, aided by an Italian engineer, M. GASPERONI, with instruments furnished by the *Cadastre*, between the highest level of recent alluvial deposit and the lake. It

proved that the surface of the lake was at least 44.94 *m.* below the valley of the Nile. I had previously made soundings in the lake, but the imminence of a dangerous storm (*Khamsin*) prevented my satisfying myself that I actually found the deepest place. At all events the bottom of the lake is not less than 150 feet below the Mediterranean. These observations, correcting the error of LINANT and LEPSIUS, were published in the *Revue Archéologique* (June, 1882). An excellent section had been published by Dr. SCHWEINFURTH from a survey made by ROUSSEAU PASHA, in 1880 (Zeitschr. O. f. E. Berlin), and ASCHERSON had also found a point in the Eastern part of the Wadi Reian 188 feet below the Nile, but these observations had not been duly noticed. My observations (1882) were wholly independent in motive and results. On March 22, 1882, having examined all the heights near Cairo, I was satisfied that the pyramids might have been natural hills.

The imminence of the outbreak under Arabi prevented my obtaining the customary facilities, and the government notified me that I must go alone. Still, it seemed to me of so much importance to obtain a section on lat. 30° that I started. Fortunately Mr. PETRIE, at that time at Gizeh, was willing to accompany me, and the section and map are based upon his entirely trustworthy measurements. These results are not only interesting as showing the varied character of that part of the earth's surface, hitherto a blank or an error; but it suggests the strategic importance of this region between Mœris and Memphis, and gives a reason why the pyramids of Gizeh should have been built or shaped out of hills on the left bank of the Nile. There is no doubt that the ancient account of Lake Mœris is substantially correct, and the restoration of the Southern Basin ought not to be far distant. The strategy of Alexander founded Herat in B. C. 327, as "the gate of India." The Hyk-Sos, who are said to have obtained a peaceful conquest over the native Egyptians, saw the agricultural, commercial, ethnic and strategic importance of the deep lake with two canals encircling its upper plateau so near to the Nile Gate of the Mediterranean, Bab-el-On or Cairo.

March 31, 1884.

LECTURE EVENING.

The President, Dr. J. S. NEWBERRY, in the Chair.

A large audience occupied the East Hall, and a lecture was given, illustrated by a collection of stone implements and lantern

views, by Dr. ALEXIS A. JULIEN, of New York, on the subject of

A SEARCH FOR FLINT IMPLEMENTS IN THE ANCIENT GRAVELS OF AMIENS.

April 7, 1884.

REGULAR BUSINESS MEETING.

The President, Dr. J. S. NEWBERRY, in the Chair.

Thirty-five persons were present.

Mr. L. P. GRATACAP was elected a Resident Member; the name of Mr. W. B. PARSONS was transferred to the roll of Corresponding Members, and the following members were elected as

FELLOWS OF THE ACADEMY:

W. P. TROWBRIDGE,	Dr. L. JOHNSON,	B. B. CHAMBERLIN,
F. G. WIECHMAN,	J. L. WALL,	Dr. A. CLARK,
A. H. ELLIOTT,	J. K. REES,	F. C. T. BECK,
H. L. FAIRCHILD,	W. H. RUDKIN,	Dr. C. S. BULL,
Mrs. E. A. SMITH,	J. F. RANDOLPH,	H. DUDLEY,
Dr. L. SCHÖNEY,	W. G. LEVISON,	J. J. CROOKE,
C. VAN BRUNT,	W. E. HIDDEN,	Dr. E. S. F. ARNOLD,
N. L. BRITTON,	C. F. HOLDER,	F. A. SCHERMERHORN,
G. F. KUNZ,	Dr. A. HADDON,	E. N. DICKINSON,
L. H. LAUDY,	A. R. GALLATIN,	B. BRAMAN.
R. P. WHITFIELD,	A. D. CHURCHILL,	

The death of Mr. THEOBALD FROHWEIN, a Resident Member of the Academy, was announced, as well as that of M. TICCINO SELLA, President of the Accademia dei Lincei of Rome, Italy.

The Recording Secretary was, on motion, requested to send letters of condolence to the relatives of the deceased in these and all future cases of the death of members.

The Academy directed the appointment of a committee, consisting of the President and Recording Secretary, to represent the Academy at the public meeting, to be held on the following Wednesday evening, to take measures in behalf of the preservation of the forests of the Adirondacks.

Mr. G. F. KUNZ exhibited a human head, carved apparently from a boulder of red sandstone, which was found on Staten Island, Richmond County, N. Y., half a mile from Fort Scott, one mile from South Beach, and 200 feet from the Staten Island Railroad. It was found by two gardeners, buried in a blue clay, under the roots of some bushes. The head shows an indentation from the blow of a pick and a few other recent markings, but otherwise appears to be ancient.

He also exhibited a boulder of rock crystal from Alaska, weighing 3 6 kgr., which was remarkably clear and pellucid, contained some fluid-cavities distinct to the eye, had a rolled surface on one side, and was reported to occur in some quantity.

The PRESIDENT remarked that the carved head displayed unusually good modelling, but still some features which suggested the Indian countenance. Its value as an antique depended upon its authenticity, in regard to which more proof was desirable.

Dr. A. A. JULIEN called attention to a critical note by Mr. HENRY W. HAYNES, in the last number of the *American Antiquarian* (Vol. VI., No. 2, March, 1884, p. 137), with whose general views he entirely agreed, but took exception to the closing paragraphs:

"But however long ago it may have been 'in the dark, backward abyss of time,' the palæolithic man, a savage hunter, armed with this rude axe of roughly chipped stone, once dwelt in the valley of the Nile, as well as in that of the Somme. President WARREN claims to have 'great respect for the palæolithic man,' and can hardly find words to express his admiration for the marvellous skill exhibited by him in fashioning 'the prehistoric arrow-head.' But unhappily, in point of fact, 'the palæolithic man' was no more capable of making a stone arrow-head than he was of building a pyramid."

In reply to the statement in the last sentence quoted, Dr. JULIEN exhibited several specimens of chipped arrow-heads and lance-heads from the lowest gravels of St. Acheul, one of which had been dug out before his eyes. Such remains were not common, chiefly, perhaps, from the difficulty of distinguishing objects of such small size, fragile nature, and rude type among the flint-nodules, but there were many such on exhibition in the museums at Abbeville and Amiens, the Blackmore Museum at Salisbury,

etc. There were even several arrow-heads figured by BOUCHER DE PERTHES among his first finds in the first volume of the "Antiquités Celtiques et Antédiluviennes," 1849, Plates XXIX. and XXX., described in Chapter XIX. The form of the arrow-heads was sometimes that of simple, rude flakes, slender and wedge-pointed, but a more characteristic and unmistakable variety, represented by the specimens exhibited, was heart-shaped, *i.e.*, triangular, with a basal indentation or nick. The evidence M. DE PERTHES had brought forward, and fully illustrated in all the volumes of his work, of the discovery of rudely formed Palæolithic knives, awls, augers, hammers, saws, etc., had been fully confirmed by later examination of the oldest gravels. In the valley of the Somme, at least, the Palæolithic inhabitant was far more than a "savage hunter," and found in the flint a material easily chipped into many useful forms beside that of a "rude axe of roughly chipped stone."

The PRESIDENT remarked on the beautiful arrow-heads of obsidian, which had been used by the native tribes in the Western territories, and which he had especially admired in a tribe in Oregon. He also called attention to an article in the same number of the *American Antiquarian*, on the subject of recent explorations in Assyria, which had given us very important additions to our knowledge of the ancient civilization of that valley.

A paper was then read by Mr. WILLIAM L. ELSEFFER, C. E., on the subject of the

HYDRAULICS OF THE MISSISSIPPI FROM CAIRO TO THE GULF.

DISCUSSION.

The PRESIDENT observed that the question was one which affected the larger portion of the United States. He had made a journey last winter with a portion of the Commission on the Mississippi River Improvement, and found, in conversation, that there was considerable difference of opinion in the Commission and among the experts. The problem was one altogether novel and untried. Without trial, by actual experiment, the people will not be satisfied. Major POWELL, of the Geological Survey, had proposed to meet the evil of the inundations at the sources of the river, by diverting the surplus water of the upper tributaries, on the west slope of the Mississippi basin, into channels for irrigation of the arid plains of the central plateau of the continent. Such an artificial supply of water is sorely needed at the

head-waters of the Missouri, if all the resources of that great area are to be brought out. It might, of course, be a question, whether this arid area could be more usefully employed if put into crops than as used at present for a grazing ground. Still the arid region lies at the headwaters of such rivers as the Arkansas, Red River, etc., where there is no great surplus of water in the streams themselves, where their flow is constant and rarely attended with floods of any magnitude. Only in the valley of the Mississippi, the great oscillations in the flow of water take place. It is entirely different with the tributaries from the eastern slope. Thus the Ohio has been, and might still be, considered a grand channel of commerce, but it has now become almost worthless on account of the oscillations of the stream, and railroads, built along its banks, are entirely supplanting the cheaper form of transport by navigation. These rivers, the Ohio, Illinois, Wabash, Kanawha, Monongahela, Alleghany, Cumberland, Tennessee, etc., throw into the Mississippi basin an enormous amount of surplus water to produce devastating floods. The plan proposed by Major POWELL will not therefore afford adequate relief. No system of irrigation, merely from the western tributaries of the Mississippi, will affect the problem, while, in regard to the eastern, no feasible method—such as constructing vast storage reservoirs near their head-waters—can be devised or carried out, with any sum which even the nation can command. The subject must, therefore, be attacked simply as a problem in hydraulic engineering. The beneficial consequences, from a successful restraint of the flow of the river, would be almost incalculable, in preventing the present devastation, and in converting the stream into a stable channel of commerce, to serve as an outlet of the surplus products of the Mississippi Valley. The inhabitants of all parts of the country must be more or less concerned in the ultimate solution of this question. If Mr. ELSEFFER can propose appropriate methods, and can show that the present plans are fallacious, he will be a benefactor not only to that portion of the United States, but to the whole country.

Mr. ELLIOTT desired a clearer explanation of the statement of the author that, even if the flow of the river should be rendered straight and uniform by the present plan, the stream would soon resume its former condition.

Mr. ELSEFFER promised to give a full explanation of this point in a succeeding paper.

April 14, 1884.

The President, Dr. J. S. NEWBERRY, in the Chair.

Forty persons were present.

Dr. N. L. BRITTON exhibited specimens of the wild liquorice bean of Brazil, which was poisonous to animals

Prof. CHARLES B. WARRING, Ph.D., of Poughkeepsie, N. Y., then read a paper on

THE UNIFORMITY OF GEOLOGICAL CLIMATE IN HIGH LATITUDES.

(Abstract.)

Geologists have confined themselves, in reference to ancient climate, to finding the cause of the remarkable warmth in polar regions. But there is another question of equal importance, perhaps even of greater. I mean the question of uniformity, not of heat merely, but of light and actinic force. That there was summer warmth is unquestionable. Was there winter warmth correspondingly high? Were light and actinic force crowded into a brief summer, or were they distributed through the year with a near approach to equality, as happens now in low latitudes?

The only means of answering these questions is found in the records of plant and animal life.

Their more obvious teachings are startling enough. Magnificent forests of magnolias, cypresses, and a hundred other species, flourished in Spitzbergen, and even farther north, as late as the Miocene, while in earlier times identical species were found from the extreme north to the equator. To this all geologists agree. The living forms to which those species were most closely allied are peculiarly sensitive to changes of temperature.* So far, therefore, as it is possible to judge the past from the present, there must have been a warm and uniform temperature almost to the poles.

It may be said that no very certain conclusions can be drawn from these facts because the identical species are no longer living, and perhaps they may not have been so very sensitive to cold as are their low-latitude successors. While there is some force in this, we must not give it too much weight, for all progress in the world's past history rests upon the belief that, in general, corals in Palæozoic times indicate such conditions as exist where we now find corals; saurians, where we now find saurians; magnolias, where we now find magnolias; tree-ferns, where we now find tree-ferns; and so of other organisms. In fact, we have no other principle to guide us. But we have direct proof of the warmth of climate in the Miocene in Arctic regions. In latitude 78° 56′ N. (in Spitzbergen), amid a Miocene flora remarkable

* If Huxley's Homotaxy is true, the same species lived first in high latitudes and then in low, or *vice versa*. The important point for my present purpose is that the same species flourished in regions where life conditions now are so extremely unlike.

for luxuriance and variety, was found one species, *Libocedrus decurrens* (Heer), which is yet living with the redwoods of California; and another yet remains on the Andes of Chili, while a third, according to Dr. GRAY, is the common taxodium or cypress of our Southern States. In Greenland, lat. 70°, were found magnolias and zamias.* All the teachings of palæontology, especially as to the earlier periods, are that there were then no zones of climate, and that there were warm arctic seas all the year round. The evenness of temperature is most extraordinary. Such a flora and fauna cannot exist where there are great variations of temperature. Yet in these same regions, the sun, if the earth's axis was inclined as now, was shut out for more than four months, while for four other months it poured down without cessation. Were a four months' night to settle down now upon the torrid zone, the accumulated heat would soon be radiated into space, and when the sun returned, no living thing would remain to greet it.

It will help us to realize the enormous effect, if we remember that the cold of our winters in our own latitude is due simply to the change from long days of summer to the short ones of winter, plus the change in altitude of the sun; but how much greater would be the cold if the sun went for four months below the horizon.

It may be said that the cold was mollified by the latent heat of the surrounding ocean, and by the influence of oceanic currents. But the same capacity for giving off heat exists now, and the same currents still flow; yet in Spitzbergen, a not large island, surrounded by a broad expanse of water, the cold is most intense. The specific heat of water has not diminished; so far as that is concerned, the ocean does as much now as then to make the winters there mild, unless there is less warm current. The effective cause of Gulf and other streams was then, as now, the difference in temperature between low and high latitudes. If that were nothing, there would be no current at all. A small difference would produce some current, a greater difference would produce a more rapid one. And this is true whether the currents are due directly to this cause, or indirectly, through the medium of aërial currents. In geological times the difference of temperature was much less than it is to-day; hence it seems within the bounds of truth to say that the ocean currents then were no greater than they are now.

Whatever warmth-producing influences existed in Spitzbergen and in other high latitudes, their effect was no greater in winter than in summer. Admitting it to have been as great—a matter of reasonable doubt—the temperature, as the days grew shorter, must have fallen until it reached a point at which the loss of heat by radiation into

* Dana's Man. Geol., revised ed., pp. 514 and 526.

space just equalled what was brought in by ocean and aërial currents. Calling the heat from these sources A, and that from the sun B, the summer heat must have been A + B. The difference between the seasons at the present day is enormous. It could not have been small at any time. Yet, somehow, "through the whole hemisphere—and we may say the whole world—there was a genial atmosphere for one uniform type of vegetation, and there were genial waters for corals and brachiopods." *

The influence of light upon vegetation is one of the clews which may lead to important results in the study of these ancient problems. At the present time the mode of applying the actinic forces varies greatly in high and low latitudes. In Spitzbergen, for example, the sun shines uninterruptedly for four months, then the days begin to grow shorter, till finally a night sets in, lasting four months. In low latitudes, the supply of chemical rays is continuous for only about twelve hours, and then ceases for a night of not greatly different length.

Light is as necessary to plant life as heat, and its evidence, as to whatever it is capable of testifying about, is far more reliable; for only the inclination of the earth's axis can affect the length of the days, while the flow of the Gulf Stream and other ocean currents, the lay of the land, and the arrangement of the land and water, have a great effect upon temperature.

The influence of environment on plants and animals has been shown by Mr. DARWIN and his followers to be very great. Unfavorable environments cause old species to disappear, and the new species, whatever their cause, are in harmony with the environments amid which they have their birth. It seems, therefore, incredible that in Palæozoic and much later times, species, identically the same, could "have flourished luxuriantly," for example, in Spitzbergen and Florida, for millions and millions of years, unaffected by such great differences in the mode of supplying the chemical rays necessary for their very existence. The argument becomes stronger when we reflect that during those years there were, from period to period, enormous changes in species—in some cases entire extermination †—new ones taking their place; yet everywhere, from the tropics to the poles, in each period one type was found. Identical species were found in all latitudes.

It seems, if possible, still more incredible that in later times, say in the Miocene, species should originate in Spitzbergen and Upper

* Dana's Manual Geol., p. 352. See also, in same work, all the earlier "Climates."

† See Dana's Manual, "*Exterminations.*" I quote one statement, page 485: "Not only every species, but also every Mesozoic genus, with perhaps one or two exceptions, became extinct at or near the close of the era."

Greenland, and thence migrate to low latitudes without change of character, if—to say nothing of temperature—the manner of supplying solar influences was then as different in the two regions as it now is.

It certainly was to be expected, if plants are to be affected by their surroundings, that natives of high latitudes, adapted to continuous months of sunlight and of darkness, would fail to endure the altered conditions, or else would exhibit indications of changes in structure to correspond to the altered requirements.

This belief is strengthened by the fact that "in receding from polar toward equatorial latitudes, the Alpine or mountain floras really become less and less Arctic." * The only changed conditions in such cases are those due to the difference in the length of days and nights.

Another corroboration is afforded by the peculiar structure of a conifer found standing in lat. 72½°,† and microscopically examined by Sir WILLIAM HOOKER. It differed remarkably from all other conifers known to him. Each annual ring consisted of two zones of tissue; the inner, narrow, of a dark color, and formed of slender woody fibres with few or no discs upon them; the outer, broader, of a pale color, and consisting of ordinary tubes of wood fibre marked with discs, such as are common to all coniferæ. These characters were found in all parts of the wood. They suggest, he says, the annual recurrence of some special cause which modified the first and last made fibres of each year's deposit; and this cause he thinks is found in the peculiarity of an Arctic climate, where the days were at first very short—a few hours only of sunshine. Then the first and imperfectly developed fibres were formed. As the days grew longer, the solar rays at last became continuous, the woody fibres became more perfect, and were studded with discs of a more highly organized structure than are usual in the natural order to which this tree belongs.

The absence of such structure in Spitzbergen, 5° further north, if established, would strengthen the conviction that such days did not occur there in the much earlier times, to which its trees belong.

Since Arctic climate, in those early periods, was warm through the year, it follows that—with the earth's axis inclined 23½°—the plants of Spitzbergen and other equally high latitudes must have spent four months of each year in darkness, and surrounded by a moist and warm atmosphere. Modern vegetation, so placed, bleaches and dies; could the result then have been different, if the axis was inclined as now?

Undoubtedly, a flora might have been specially organized for such

* Quoted approvingly by Mr. Darwin, in Origin of Species, from Mr. H. C. Watson.

† See account in *Climate and Time*, pages 264 and 265.

conditions, but all through the earlier ages there were no special floras for different latitudes. One type prevailed everywhere.

The marvellously luxuriant foliage of the Arctic trees has excited the surprise of LYELL and others.

It is a matter of common observation that plants receiving the full intensity of the sun's rays have smaller leaves than their fellows of the same species which are somewhat protected. It would seem as if nature compensated for the inferior intensity of the solar rays by giving more surface to be acted upon. Since the intensity of the sun's rays varies as the cosine of the latitude, it is evident that, while the length of the day in Florida and Spitzbergen would be the same, with the sun all the year on the equator, the intensity of the light in the former would be almost twice as great as in the latter. Hence, if the earth's axis was in fact nearly, or quite, perpendicular, and if, in some way, the temperature was kept the same, we ought to look for greater size of foliage—greater "luxuriance"—in very high latitudes than in low.

The existence of annual growth-rings in the early exogenous plants is not proof of the existence of seasonal changes, for such rings may be formed several times in a summer, or not all, or once in several years. I have seen a hard and woody stem of *Chenopodium album*, less than four months from the seed, with eight well-formed rings. A woody Phytolacca, according to Dr. Gray, makes at least twice as many layers as it is years old. The Cycads require several years to make one. The orange and lemon, in greenhouses where the temperature is kept uniform, form layers as regularly as do our forest trees. The mangrove, which grows between high and low-water mark on the sea-shore in tropical regions, forms well-marked rings. In its case there is no seasonal change, either from warm to cold or from wet to dry. Hence I infer that the presence of these layers, or growth-rings, is not due to influences connected with the seasons, and, therefore, has no bearing upon the question of the inclination of the earth's axis.*

I think we may say that the teachings of geology are what they would be if the earth's axis was in those times nearly or quite perpendicular to the ecliptic, providing that in some way the temperature was kept sufficiently high.

Nor is it any argument against the axis having formerly been in that position that no traces are found of such a cataclysm, when it changed to its present obliquity, as would have attended an equal change in the geographical position of the poles. The latter would have necessitated a great overflow of the ocean, while a change of inclination, if

* For a fuller discussion. see Am Jour. Sci., 1878, Article XIV., entitled, "Is the Existence of Growth-rings in Exogenous Plants Proof of Alternating Seasons?"

at all gradual, would produce no visible effect. All it could do was to affect the length of days and nights, and, consequently, introduce seasons. These changes, if they occurred, would have registered themselves in changes in the plants and animals of high latitudes; while in low latitudes no perceptible effect would have been produced, and, consequently, the species would continue as they were before. Geology teaches very clearly that in high latitudes there did occur toward the end of the geological record a complete disappearance of old species, while in low latitudes they were unaffected.

The conclusion toward which these facts point would be readily accepted, were it not for reasons derived from another source than geology. Astronomers say that a permanent change in the inclination of the earth's axis is impossible, so far as any force is concerned which is known to science. But, as this is equally true of many other things which have actually been done, it is not an insuperable objection. "No force known to science" can vivify matter, yet living beings are all around us.

There are only two theories as to the existence of our world. The one attributes it to an Omnipotent Intelligence, that, for His own purposes, made the universe, and, by His wisdom and power, brought it through stages of development, some of which we have been able to recognize, and some so far to understand as to class them with others, and then, having named the order in which the events are arranged, call it "law," and sometimes think we have thereby comprehended it.

The only theory of the solar system on mechanical principles is the nebular hypothesis in its several forms. In all, the earth and moon were once one body, revolving, of course, on one axis. At some remote time they separated. But no force of avulsion, whether the moon was left behind as the mass contracted, or whether, as has been more lately held, it was thrown off by the great centrifugal force after the earth had become solid, and then was gradually pushed back by the influence of the friction of the tidal wave, could affect the plane of rotation or the direction of the axis of either. On mechanical principles, the moon, when it left the earth, moved in the plane of the earth's equator, and the axis of the earth and the moon and of its orbit were parallel to each other. The normal position of the three was perpendicular to the ecliptic. But now the axis of the moon is inclined $1\frac{1}{2}°$, and that of the earth $23\frac{1}{2}°$. Very evidently, either the earth's axis or the moon's has changed. The moon's axis is now nearly in the normal position. Hence I conclude that it was the earth's axis that changed.

Astronomy, therefore, proves too much. It proves that the present condition is not eternal, that normally the axis was perpendicular to

the ecliptic, and that once in any position it can never change* "by any force known to science." To all of which those of us who are not astronomers can only answer—What you say may all be true, but, nevertheless, the axis has been tilted over to $23\frac{1}{2}°$ by means of some force not known to science. And if we cannot tell how it occurred—an inability which extends to a great many things besides this—our business is to discover, if we can, when it occurred. It is not a question of possibilities, but of chronology. The uniformity of biological conditions in high and low latitudes indicates that the present obliquity had not been attained in Archæan, or in Palæozoic, or in Mesozoic times. A similar uniformity prevailed in the Tertiary till toward its close; then comes a blank of unknown length, during which the Glacial epoch came and went, and then, when the record again begins to be legible, there are, for the first time in the world's history, indications of zones of climate and of alternating seasons. This seems to fix the date of the increase of axial obliquity as corresponding to the Glacial epoch.

It requires no argument to show that a perpendicular axis would account for the otherwise inexplicable evenness of ancient climate. Ocean currents might bend the isotherms, but at any place the temperature, whatever it was, would be the same all the year. The hours of light and darkness would be the same everywhere.

This kind of uniformity is, however, compatible with great cold, and does not touch the question of a warm polar climate. Many theories have been proposed to account for the remarkable temperature. Six or seven are ably treated by SEARLES V. WOOD, Jr., in the *Geological Magazine* for September and October, 1876, and by Dr. CROLL in *Climate and Time.* Dr. CROLL'S theory differs from those. To it there are what seem insuperable objections. I have discussed this theory somewhat fully in *Penn Monthly* for June, July, and August, 1880, and shall not now repeat.

Professor WHITNEY has lately put forth another explanation, in which he attributes the preglacial warmth to the sun itself being hotter. All conclusions in regard to the sun's former temperature must be hypothetical; but if it be a gaseous body, as suggested by Professor YOUNG, it has been growing hotter all the time it has been condensing.† To this, as to all other theories heretofore advanced, lies the objection that they ignore the uniformity which is such a remarkable feature of geological climate.

* There is a small secular change of obliquity going on now, but it oscillates about a mean position.

† A fact discovered by Mr. J. H. Lane. See *American Jour. Science*, July, 1880; also, Newcomb's Astronomy, page 508.

Mr. MEECH has shown that with a perpendicular axis polar regions would receive during the year less heat than they do at present; hence Dr. CROLL infers that with such an axis polar climate would be less genial than it now is. This would be true if temperature depended solely on the amount of heat received. But, as everybody knows, it depends far more upon the amount of heat retained. Greenhouses are often uncomfortably warm when the temperature without is near freezing. The solar rays readily enter through the glass, and are absorbed by the floors, walls, etc., while the heat which they radiate back is unable to escape. Professor TYNDALL has shown that many substances possess this property, and among them are aqueous vapor and carbonic acid gas.

The amount of carbonic acid in the atmosphere must have been far greater in ancient times than now, for all the graphite, coal, lignite, etc., now in the earth's crust once existed in that form. With the beginning of plant life a process of elimination commenced. It continued till near the end of the Tertiary, when the amount taken out by living forms and that restored by their decay became equal—a condition which still exists.

The carbonic acid was then, as now, uniformly diffused, and it acted as glass does in a greenhouse. It kept the heat in, and, consequently, the atmosphere itself grew warmer. This increased its capacity for moisture, and that, in its turn, helped to retain the heat.

In this, I think, lies the cause of the warm polar climate, those otherwise cold regions being protected by this warm "double blanket." Prof. TYNDALL says: "The removal for a single summer night of the aqueous vapor which covers England would be attended by the destruction of every plant which a freezing temperature could kill."

Besides the carbonic acid and water vapor, there were probably other gases and vapors in the atmosphere. Ammonia produces 13 times the effect of CO^2, and marsh gas $4\frac{1}{2}$ times. Whatever there were of these, they tended to increase the potency of that "warm blanket."

The amazingly slow change of temperature—many millions of years to reduce it from that of the Archæan to that of the later Tertiary—finds reasonable explanation in the effect of these gases and vapors. Prof. TYNDALL has shown that, commencing with a vacuum, and adding a small number of very small increments, the absorption is sensibly proportional to the increments, but as the quantity increases, the deviation from proportionality augments (*Heat a Mode of Motion*, page 356); at length a condition is reached in which further increments produce very little effect.

The converse of this is very important. Commencing with a large

amount of the gas or vapor, a very great number of decrements will be needed to produce any sensible effect ; then a less number, and so on, until toward the end, when the decrement needed will be small and the effect comparatively large. Hence temperature changes should have been at first, and for a long time, very slow, and afterward much more rapid. All we know about what did occur is derived from the study of the plants and animals and noting what changes occurred among them ; the results of such study appear to be in harmony with what we should expect. The peculiar life of the Palæozoic lasted several times as long as that of the Mesozoic, and that several times as long as the peculiar life of the Tertiary, and in the Tertiary itself the changes were most rapid of all.

It is also very suggestive that while the changes in the plants and animals in the earlier periods were world-wide, the changes in the Tertiary were more and more confined to high latitudes, as if the cold were settling down from the poles toward the equator. This was to have been expected if the early polar warmth was due to that "warm blanket." If this was growing thinner, it might be long before any sensible effect was produced ; but when it did appear, it would first manifest itself near the poles, where so much depended upon the heat's being retained.

With this in view, there is no difficulty in seeing why the flora of temperate America and of Europe and Asia should have their origin in very high latitudes, since, while light and actinic force were always fitted for them, it was there a temperature first appeared which was adapted to their needs.

The amount of carbonic acid possible in the atmosphere without destroying life is not known, but according to Prof. REMSEN of Johns Hopkins University, present animals can breathe an atmosphere containing five per cent. of that gas, "without experiencing serious or even disagreeable effects." This is one hundred and fifty times, and more, the present amount. With animals specially adapted to it, I see no reason why the quantity might not in those days have been very much greater than five per cent.

The Glacial Epoch, and the subsequent Warmth.

The "warm blanket" having been so greatly reduced, the perpendicular axis was permitted to produce its natural effect, and the climate "became less genial than now." The cold, moreover, was intensified by high latitude uplifts. We may get some idea of the result if we imagine New York State, for example, elevated to a considerable height, and if the sun never rose any higher than it now does on the 21st of March. All present vegetation would die out, and

if the conditions as to elevation continued to the north of us, it would not be necessary to go far to find perpetual snow. For snow once fallen or ice once formed, would never melt, but, accumulating through the ages, would force its way south by its own weight, until it reached so far below the true snow line as to be melted.

Such uplifts to-day, the atmosphere remaining as it is, and the earth's axis again becoming perpendicular, would bring back the Glacial epoch.

The warmth of the Champlain was due to a reversal of these conditions. From some cause the axis had attained its present obliquity, this of itself rendering the climate of polar regions more genial, while the depression of the land below its present level, and the consequent extension of ocean surface, greatly aided and accelerated the result.

A moderate and comparatively local uplift, mostly confined to the eastern continent, would account for the minor Glacial period which seems almost confined to that part of the world.

Subsequent changes of elevation left us the climate of to-day.

SUMMARY.

1. The early warmth was due to the "blanket" of carbonic acid, aqueous vapors, and probably other gases and vapors.

2. The uniformity—lack of seasonal changes, and the equality of light and actinic force—was due to the axis of the earth being nearly or quite perpendicular.

3. The slow fall of temperature at first, the more rapid fall in later times, and the cold of the Glacial epoch, were due to the gradual purification of the atmosphere, and, with reference to the cold, to great high latitude uplifts.

4. The return of warmth was due to increased obliquity of axis, and to high latitude depression of the land and consequent extension of the ocean.

5. The Champlain warmth was due to the extreme depression.

6. The minor Glacial epoch was due to comparatively sudden and local elevation.

7. Present climate is due to present arrangement of land and water and to the introduction of seasons, or, in other words, to the present relation of day and night.

The influence of vapors and gases on climate was pointed out by Prof. TYNDALL and others. Several have proposed a change of inclination or of geographical position, as a solution of the climatic problem. DANA and others have spoken of the high latitude uplifts and the subsequent depression. The theory in this paper weaves all these and

many other facts into one theory in which each bears a definite and important relation. In its entirety I claim it as new, and as differing widely from all that have preceded it.

DISCUSSION.

The PRESIDENT stated that he had been led to think that not quite so much uniformity of climate had prevailed in former periods as is often supposed. A very warm temperature had existed at the north in Tertiary times. However, there had been also great variation in lower latitudes, ranging from tropical heat to a very cold climate when the ice overspread the land. But no evidence had been shown that these temperatures were synchronous. A remarkable fossil fauna of tropical character had been discovered by BONPLAND in Bogota ; but we were not in possession of facts permitting us to assert that these ammonite deposits of South America were laid down at the same time as those in the North. There was, on the other hand, considerable evidence of the occurrence of alternations of climate. High tides of temperature had existed certainly in different parts of the globe, but there was no evidence that these had occurred at the same time. Thus the discovery of bodies of floodwood, left by earthquake waves at high points on different coasts, would be no evidence that these were deposited by the same flood over the whole globe.

In Palæozoic time, comparatively moderate irregularities in temperature had prevailed, the sea being more uniformly distributed over the surface. During the Carboniferous period, the temperature was moist and equable, producing a luxuriant vegetation, but favorable also to the preservation of vegetable deposits. At the present day, peat accumulates in the greatest quantity wherever the climate is cool, moist, and equable—therefore, not in the tropics, where the wood is burned up under present conditions, and where it was not accumulated during the Coal-period.

The plants of the Cretaceous were similar to those of the present day ; many genera in fact were identical with those now growing, *e.g.*, the sassafras, magnolias, liriodendrons, etc. There was no evidence of a tropical vegetation in the early Cretaceous. Later, however, palms and other tropical forms began to appear. The climate was in general of a temperate character.

The Tertiary deposits were characterized by a luxuriant though not tropical vegetation, such as is found in warm climates at the present day. Thus the deciduous cypress now reaches as far north as our Central Park in this city, but its natural habitat is further south. In

Tertiary times, it grew in Greenland. In Alaska, oaks once flourished whose leaves were twelve to fifteen inches in length. The leaves of trees were, as a whole, smaller than in the tropics, where at the present day the largest leaves are found, such as those of the banana, etc.

This flora, growing in a mild climate, was mostly destroyed by the Ice period. This great change was probably caused by some cosmic influence, and not by the elevation of high lands in the Arctic. In the Tertiary age, the northern lands were deeply furrowed by valleys opening into the sea, thus producing the fjords to which the fimbriated appearance of all the northern coasts has been due. There is evidence of the occurrence of a great flood which afterward transported the material from which the Champlain clays were separated, the finest sediment having been deposited in bodies of still water. These clays were synchronous with the coarser deposits of gravel and boulders, on the higher lands. The elevation of the sea-level, indicated by the Champlain deposits, amounted to about 100 feet at New York City, 200 feet at Albany, 500 feet at Montreal, 800 feet at Labrador, 1,000 feet at Davis Strait, and finally reached, in the Champlain clays of Polaris Bay, a height of 1,600 to 1,800 feet above the sea. All these clays contained the remains of Arctic shells, and these implied a low land level during the latter part of the Ice period.

There is a difficulty in accepting the idea suggested by Prof. WARRING, that the axis of the earth was then perpendicular to the ecliptic. No change in the constitution of the atmosphere could permit the existence of a high temperature in the Arctic and its absence in tropical regions.

In the Cretaceous period, anterior to the luxuriant vegetation of the Tertiary, a climate and vegetation of a temperate character had prevailed here. The increase of carbonic acid in the atmosphere would make conditions incompatible with these facts. It has been shown that a vast amount of carbonic acid has been also withdrawn to produce all the deposits of limestone; this would involve an enormous percentage in the constitution of the original atmosphere of the globe. To meet this difficulty, WINCHELL had suggested that there had been a constant addition of carbonic acid to the atmosphere from space. Sir HENRY SIEMENS had also suggested, in *Nature*, about a year ago, the constant addition of both aqueous vapor and carbonic acid from space.

We have testimony from the astronomers in general opposition to the view of any change in the axis of the earth; they have almost unanimously pronounced against the probability of this idea. One or two of the evidences, which have been cited, of the former existence of a very high temperature at the north, are fallacious, *e.g.*, the abun-

dant growth of corals. There is no evidence that a high temperature was required to produce these coral masses. It was true that the corals were aggregated together in such a way as to imply a luxuriant growth, and that, at the present day, all the evidence tends to show that reef-building requires a warm climate. It was found that, on the land nearest to the coral-reefs of the Devonian seas, tree-ferns grew, which were of as large size as any now growing in the tropics.

Since Palæozoic times and the formation of the present topographical features and the interruptions of the great oceanic current, the changes which have occurred may indicate cosmical interferences of some kind. In conclusion, he would only suggest that the problem was very complicated and required the consideration of many facts.

Prof. WARRING stated that the view he had offered did not indicate a uniformity of climate over the twelve months. He had wished to direct attention merely to the absence of the changes of the seasons in former geological periods.

The PRESIDENT remarked that the alternations of temperature on this continent often reached 100° of Fahrenheit or more at the same locality during a single year. This indicated the endurance by our vegetation of a great range in changes of temperature. In our winter the temperature often drops 25° in a few days. This was a greater trial to the vitality of a plant than a steady cold. He could not imagine that the economy of plants would be greatly affected by polar conditions.

Prof. HUBBARD remarked on the wide variations in temperature which frequently occurred in the latitude of Boston, sometimes amounting to 142° at that city.

Prof. WARRING called attention to the peculiar kinds of plants which thrived in Miocene and earlier times. Their fellows in tropical latitudes, at the present day, were very sensitive to changes of temperature. So far as concerned the doctrine of environment, how could plants so entirely unlike have been developed under such different conditions ?

The PRESIDENT pointed out that some plants of the northern Tertiary have even now a wide range ; thus, the Sweet Gum, though found over our continent, is far more abundant in Louisiana. The Sassafras has also a very wide range, extending from Canada to the Southern States, even into Texas. The Magnolias, which are found in the fossil state, are not identical with the species of the present day ; but the modern species, the cucumber tree, has now a wide range. There were vast numbers of plants in the Tertiary of the Arctic which

have since disappeared. As the climate became severe, with the approach of the Ice period, they retreated southward. As it became again milder, only a few survived and once more returned. Thus, the Sequoias were found fossil in numerous species, reaching to the Arctic Sea, spreading over the continent in luxuriant forests, consisting of magnificent trees, but of these only two species now survive.

April 21, 1884.

LECTURE EVENING.

The President, Dr. J. S. NEWBERRY, in the Chair.

A large audience occupied the East Hall.

Professor F. W. PUTNAM, of Cambridge, Mass., delivered a lecture on

RECENT DISCOVERIES IN THE PREHISTORIC MOUNDS OF OHIO.

April 28, 1884.

SECTION OF PHYSICS.

The President, Dr. J. S. NEWBERRY, in the Chair.

A large audience was present.

Professor H. CARRINGTON BOLTON, of Hartford, Conn., read the following papers, which were illustrated by many specimens :

I. THE "SINGING BEACHES" OF THE BALTIC.

The speaker stated that, since presenting his first paper (on March 10th), he had received intelligence of thirteen additional localities of sonorous sand on the Atlantic coast, chiefly in New Jersey and North Carolina.

The late Dr. MEYN, in his "Geological Description of the Island of Sylt," mentions briefly the occurrence of sonorous sand on the Island of Bornholm, an island belonging to Denmark, in the Baltic. Since the quartz sand of Sylt does not have these acoustic properties, Dr. MEYN jumps to the conclusion that this quality of sand may be used to distinguish that of Tertiary and of Jurassic origin. This is obviously an error, resulting from attempts to generalize on a single observation. The acoustic quality of the sand is entirely independent of its geological horizon.

Through the kindness of Professor S. F. BAIRD, Secretary of the Smithsonian Institution, we obtained samples of sonorous sand from

Colberg, Prussia, accompanied by a letter from Dr. G. BERENDT, Professor of Geology in Berlin. Dr. BERENDT states that the sand of the Baltic coast of Prussia has the peculiarity under consideration in many localities, but only transiently. Small tracts which squeak under foot on one day fail to do so on the following day, and new places are at times endowed with the acoustic properties. Hence, he attributes the cause to a crust left by the retreating tide, which is only temporarily coherent. Such phenomena occur on the Kurische Nehrung and on the Samländische Strande of East Prussia. He rejects MEYN'S views above reported.

Sonorous sand occurs on the largest scale on Kauai, one of the Hawaiian Islands. The sand forms a dune 100 feet high, and when disturbed slides down the incline, producing a sound as of distant thunder. This sand has been examined, microscopically, by Dr. JAMES BLAKE, who found it to consist mainly of portions of calcareous sponges and coral, all more or less perforated with minute holes, tubes, and cavities. A small proportion of crystalline silicates, augite, nepheline, etc., is also present. Dr. BLAKE ascribes the sound to the reverberations excited by motion of particles within these minute cavities. Through the kindness of Rev. JAS. W. SMITH, M.D., of Kauai, we have received samples of this sand, and through the Smithsonian Institution larger samples of the same. These are now under further examination. All but five per cent. proves to be soluble in cold dilute acetic acid.

II. SONOROUS SAND-HILLS OF ARABIA AND AFGHANISTAN.

From a very early period travelers in Asia have heard rumors of mysterious sounds issuing from sandy wastes and hills, which they commonly regarded as fables. The Emperor BABER describes briefly such a sand-hill as early as the 15th century. The first European to publish an account of one of these localities was Dr. U. J. SEETZEN, a Russian traveler who visited in 1810 the since world-renowned Jebel Nakous or Mt. of the Bell. This hill of sonorous sand is situated on the Gulf of Suez, a few miles north of Tor. The speaker stated he had collected for the first time the narratives of six several visitors to this region, viz., of Dr. SEETZEN in 1810, Mr. GRAY in 1818, EHRENBERG in 1823, Lieut. WELLSTEDT in 1830, Professor HENRY A. WARD in 1855, and Professor E. H. PALMER in 1868. On comparing carefully the accounts given by these travelers, the speaker came to the conclusion that they had visited three and perhaps four different localities within a given region north of Tor and on the east shore of the Gulf of Suez. The discrepancies as to distance of the place from the sea, its height and its general character, are so great that they can be explained in no

other way. On writing these views to Professor WARD, he replied in a letter acknowledging their correctness. All the travelers, however, concur in describing quartz sand resting on an incline and possessing very great sonorous power. Agitation of the sand causes it to slide down the incline, and, as it moves, a noise resembling at first a humming, then a roaring, increasing in volume until it is likened to distant thunder. Professor PALMER noticed also the production of a slight sound by sweeping portions of the sand rapidly forward with the arm, which, moreover, caused a peculiar tingling sensation in the operator's arm. All the observers agree in noting the perfect dryness of the sand, and Professor PALMER thought the heated sand issued louder sounds than that in the shade. The Arabs residing in Tor ascribe the sounds to strokes by a priest on a *nakous*, or gong, calling his fellow-monks to prayers in the monastery concealed within the bowels of the earth.

Two wonderful sand-hills have been described by travelers in Afghanistan. One, forty miles north of Cabul, was visited by Sir ALEXANDER BURNES in 1837; the second, 150 miles south of Herat, near the borders of Persia, was visited by Capt. EVAN SMITH in 1870–72. The general characters of these places resemble those of Jebel Nakous, and the sounds emitted by the moving sand are similar. Reports have been made of a sonorous dune in Nevada, twenty miles south of Stillwater, in Churchill County. This dune is said to be 100 feet to 400 feet high and four miles long; when agitation of the sand starts it sliding, a noise is produced like that from telegraph wires fanned by a breeze.

The localities in which sonorous sand is found may be divided into three classes: *first*, sea and fresh-water beaches, where all the sand possesses the sound-producing quality permanently, as at Eigg, Manchester, Plattsburg, etc.; *secondly*, sea-beaches where small tracts of the sand possess acoustic properties transiently, as along the Atlantic coast, in New Jersey, North Carolina, and on the Baltic; *thirdly*, sand-hills in the interior or otherwise, whose steep slopes give rise to acoustic phenomena of great magnitude, as at Kauai, in Nevada, and at Jebel Nakous and Reg Ruwan.

Investigations to determine the true cause of the sonorous property of sand are in progress. Any information concerning new localities, and samples from the same, will be received very gratefully.

May 5, 1884.

REGULAR BUSINESS MEETING.

The President, Dr. J. S. NEWBERRY, in the Chair.

A large audience was present.

Mrs. A. C. KETCHAM and Dr. R. H. LAMBORN were elected Resident Members.

A paper was then read by Dr. LOUIS H. LAUDY, illustrated with apparatus, experiments, and lantern-views, entitled

PHOTOGRAPHY—PAST AND PRESENT.

May 12, 1884.

SECTION OF GEOLOGY.

The President, Dr. J. S. NEWBERRY, in the Chair.

Thirty-seven persons were present.

The PRESIDENT exhibited specimens of vanadite, descloizite, and a large suite of polished colored marbles from Vermont.

Mr. G. F. KUNZ exhibited specimens of a remarkable chlorophane from Amelia County, Va., phosphorescent by friction, the heat of the hand, etc.

The PRESIDENT, in discussing the subject of phosphorescence, referred to the specimens of luminous limestone from Utah, which he had exhibited at a former meeting. It had been reported that the blows of the pick upon this substance had kept the tunnel continually illuminated. This phenomenon, being a novel one to the miners, had caused them great alarm lest the mine might be getting on fire.

A paper, illustrated with a suite of specimens, was then read by Mr. ARTHUR H. ELLIOTT, on

THE COLORED MARBLES OF LAKE CHAMPLAIN.

DISCUSSION.

In reply to inquiries, the author stated that he had found no sulphides in these marbles. In regard to their durability as building stones, he had observed that their weathered surfaces looked remarkably hard and apparently very fresh. In Burlington, a few buildings had been erected from the Willard's Ledge stone and seemed to present good evidence of its durability. At the Swanton quarries all the surfaces had been freshly uncovered, and the weathered edges appeared sharp. In Swanton a church had been erected some years ago, and the stone was well preserved. Fossils have been observed in the black marble.

In regard to the cause of coloration, some varieties are brecciated (the "dolomitic breccias" of Hitchcock), and in these the coloring material is generally oxide of iron, but in the Isle La Motte marble carbonaceous matter produced the color, the percentage of water and organic matter amounting to 1.40.

The PRESIDENT exhibited a large collection of similar colored marbles from Vermont, and remarked that he had studied and reported upon them at the Centennial Exposition.

One variety from Plymouth has not yet entered into commerce. The demand for the colored marbles was increasing with the growing luxury of the times and the appreciation of their beauty by the people. However, it was likely that the lighter-colored marbles would always be more extensively used, in the proportion of one hundred to one, than the colored. The Winooski was already in general use, though worked with difficulty on account of its density and its high content of silica, this substance being sometimes present in geodes. It had been often used, mistakenly, in this city for pavements, doorways, etc., but, like all the colored marbles, it both weathered and wore unequally, in consequence of its veins, etc. A most beautiful collection of colored marbles had been exhibited from Maryland, rivalling any that had been used by the ancients in the Old World. Very few of these had yet been worked and polished, but many very brilliant specimens had been shown at the Centennial Exposition. In the far West, wherever the limestones have been affected by metamorphism, marbles occur in exceeding abundance, *e.g.*, in the Rocky Mountains and the Sierra Nevada. They occurred also along the Alleghanies, as in West Virginia and Tennessee. In Vermont, at Rutland, white marbles occur of very great importance. At Pittsford, also, a heavy bed of marble occurs, 450 feet in width, the stratum standing nearly on its edge. In this vicinity some of the marbles have been used for building.

He also exhibited a specimen of black marble, veined with white, from Southern Nevada. This rock had evidently been shattered, and the crevices infiltrated by white carbonate of lime. Iron oxide, sometimes as a greenish silicate, was the almost universal coloring matter of the limestones.

But recently native tin had been discovered in the Black Hills; in fact, from the diamond to coal, the resources of that country were ample. So, too, the black marbles of the West will be ready when there will be a demand for them.

In the Old World, the colored marbles, in an enormous series, came into use at an early date. Many of the quarries, known to the Greeks and Romans, are indeed as yet unknown to us; but many have been

re-discovered even quite recently. The locality of the *rosso antico*, used in Rome by the Etruscans, before the time of the Romans, was still unknown to us. This material was used for a great number of purposes, commonly as mouldings, as we now use wood. Another unknown locality, though probably in Belgium, was that of the black marble, *nero antico*, of the Egyptians. The Romans scoured the world for black marbles. The best collection of specimens of fine marbles could now be made, not by going to the marble-quarries but to the crumbling monuments of Rome. A collection of a thousand specimens, all different, had been made by an architect of Rome. Nowhere else now did such a variety exist.

The white marbles are also now growing into greater favor for many purposes. It was exceedingly important that the vast variety of building materials now brought into New York City should be thoroughly investigated.

Mr. ELLIOTT remarked that he had seen some small pieces of statuary, made from the Pittsford marble. The material was very beautiful and translucent.

The PRESIDENT observed that really good statuary marble was exceedingly rare. For the Pentelican marble of the ancients we have yet no substitute. The material of the layer of statuary marble of West Rutland was very beautiful but rather tender. At Pittsford, also, an exceedingly interesting variety was found, white, strong, and of excellent quality. Other varieties of cloudy, blue, dove-colored, and banded marbles had been recently discovered, which were very beautiful.

May 19, 1884.

LECTURE EVENING.

The President, Dr. J. S. NEWBERRY, in the Chair.

A large audience occupied the East Hall.

Prof. H. CARVILL LEWIS, of Philadelphia, Pa., delivered a lecture, illustrated by drawings and lantern-views, on the subject of

THE GLACIAL EPOCH IN NORTH AMERICA.

May 26, 1884.

SECTION OF BIOLOGY.

The President, Dr. J. S. NEWBERRY, in the Chair.

Sixty-three persons were present.

The resignations of Messrs. CHAS. A. NASH, T. WOLCOTT, and Dr. W. G. WYLIE, as Resident Members, were then accepted.

A paper was read by Mr. E. A. CURLEY on

BEES AND OTHER HOARDING INSECTS : THEIR SPECIALIZATIONS INTO MALES, FEMALES, AND WORKERS.

DISCUSSION.

The PRESIDENT referred to the many investigations by DARWIN and others, in reference to this mysterious action. The subject was by no means exhausted. It seemed probable that the diminution of food, by decreasing the reproductive organs, would tend to result in the decrease of the number of perfect action. In view of the sterility of the neuters, in bees and ants, their reproduction and continuance appeared mysterious and unaccountable, unless an extremely artificial condition of society had been reached among them. If the mother could feed the larva in such a way as to incapacitate, intentionally, the greater number of the young, this method would produce the actual result. This could have been reached only by a long and curious process of development.

In New Mexico occurred the honey ants—those in which the production of honey was increased. They were fed by the others, grew, and were ultimately and systematically slaughtered as food by the other ants. Twenty-five years ago, he had some of their hives opened and brought them home. These have been since studied by Rev. Mr. MCCOOK and others. We cannot reconcile a process like this in harmony with many known views.

The sterility of ants and neuters was indeed an utterly incomprehensible fact. It was possible to imagine that it could be effected by some artificial process, as it were, by a dose of medicine supplied by the mother of the hive, or possibly by some modification of their food. A bridge which fails to cross the stream has no right to exist ; so also, any phenomenon which shows no evidence of derivation from gradual growth of some beneficial influence.

The increase of food does not, as a rule, increase the fecundity of the plant or animal. A certain narrowness or limitation of food sometimes tends far more to increase the rate of reproduction. For example, in the tropics, the floral beauty is comparatively less prominent than in the temperate zone or far north, because not so dependent upon the co-ordinate work of the insect. Many evidences occur to every biologist to indicate such facts as these, in which the general tendency, explained in the Darwinian hypotheses, is in progress.

A paper was then presented by Dr. J. S. NEWBERRY, illustrated by drawings and lantern views,

ON THE ORIGIN OF PUGET SOUND, AND ITS CONNECTED SYSTEM OF TIDEWAYS.

June 2, 1884.

REGULAR BUSINESS MEETING.

The President, Dr. J. S. NEWBERRY, in the Chair.

Fifty-seven persons were present.

It was voted to adjourn the business meeting to June 9, in order to act on business to be proposed by the Council.

The PRESIDENT exhibited specimens of crocidolite from South Africa, of native iron in basalt, from Greenland, and of fossil star fishes from the Devonian of Europe.

Mr. G. F. KUNZ stated that the crocidolite had originally the hardness of 4 or 5, but the individual fibres of crocidolite have been all encased or coated with ferruginous quartz, making the hardness of the mineral about 7—virtually a quartz-catseye. Mr. GREGORY, of London, first worked the vein in the year 1866. The mineral being in some demand, two expeditions had been sent to procure it, and in consequence the locality had been well examined, and tons of the material procured. This resulted in the loss of many thousands of dollars by the dealers, who invested largely in it at six dollars per karat. It is now sold at twenty-five cents per pound in quantity.

The PRESIDENT remarked on the character of the alteration, which had been accompanied by an increase in the amount of silica and the addition of water. He then exhibited specimens of realgar from Felsobanya, Hungary, of square prisms of humboldtilite, in slag, and of spines of *Gyracanthus tuberculatus* (?) Ag., from the Coal-measures at Lesmahagow, Scotland.

Mr. G. F. KUNZ then exhibited a collection of gems, some from the famous Poniatowski collection, which had been offered for sale as veritable antiques in the London market. He also dis-

played other specimens and machinery, in illustration of his paper on

A NEW PROCESS OF CUTTING INTAGLIOS AND CAMEOS, SO AS TO PRODUCE THE FINER EFFECTS OF THE ANCIENT GLYPTIC WORK.

DISCUSSION.

A MEMBER called attention to the interesting fact, recorded by Pliny the Younger, of the emerald of the Emperor Nero, which had been cut in the form of a double convex lens.

The PRESIDENT remarked on the great interest of historical records connected with engraved gems, as illustrated by the ancients. Schliemann's discoveries of engraved gems had accumulated largely with the progress of his excavations.

The work of the engraver was carried on in the most early times of history. The number of ancient gems, represented in the work of KING on this subject, indicates that this was then a very common form of art. The great hardness of their material has resulted in their frequent and often perfect preservation for long periods. Gems were cut long before the discovery of the diamond, corundum being commonly used for the purpose, in powder. There was even reason to believe that the first architectural excavation and piercing of granyte had been effected by this means. The ancient Pelasgic monuments show evidence of having been fashioned by means of bronze tools and this mineral in powder. In piercing holes, a tempered solid rod had evidently been often employed; the principle of the diamond-drill was therefore very ancient.

A paper was then read by Mr. EDWARD W. MARTIN, illustrated by lantern views, on the subject of

PHOTOMICROGRAPHY—PROCESSES AND RESULTS.

DISCUSSION.

Dr. JULIEN called attention to certain present limitations of the process, and to new methods and apparatus recently proposed to obviate these difficulties.

The PRESIDENT remarked that hereafter lantern slides will be brought into use to display and illustrate the infinitely little as well as the infinitely large. The problem of a satisfactory microscopic attachment to the lantern still remained unsolved at present; only one or but a few persons can well see the same microscopic object at one time. The electric light was full of promise in this direction, whether by means of storage batteries or of some method for the generation of electricity

near or at the lantern, but it was, as yet, too much of a fixture. The satisfactory accomplishment of the application of microscopic augmentation to lantern slides, as to other objects, would be of great benefit to the educational world.

June 9, 1884.

ADJOURNED BUSINESS MEETING.

The President, Dr. J. S. NEWBERRY, in the Chair.

Fifty-five persons were present.

Dr. J. H. RIPLEY, Dr. ROBERT B. TALBOT, and Mr. LUCIUS PITKIN were elected Resident Members. The report of the Council was read.

On motion, it was *Resolved*, that the President and Secretary be authorized, at their discretion, to give the required notice of the termination of the contract with the Trustees of the American Museum of Natural History, concerning the Academy's library deposited in the Museum, when another suitable place shall have been provided.

After a full exposition by the PRESIDENT of the relations of the parties to this contract, and the possibility of bringing the library to a locality more convenient of access by the members of the Academy, it was further voted—

That the President and Secretary are also authorized, on the termination of the said contract, to provide a new depository for the library which shall best combine conditions the most certain for its care, security, and independent use.

The Council recommended that a Committee be appointed to solicit contributions for a publication fund to meet immediate wants and the future needs. After discussion it was voted that a Committee of twelve be appointed by the Chair for this purpose.

The following Committee was so appointed :

J. MCDONALD,
J. D. WARNER,
C. VAN BRUNT,
L. SCHOENEY,
Mrs. H. HERMANN,
Mrs. E. A. SMITH,
A. J. TODD,
Mrs. V. K. HASCALL,
G. F. KUNZ,
A. A. JULIEN,
H. L. FAIRCHILD,
C. F. COX.

Professor FAIRCHILD represented the need of information among the members of the Academy and the public, in regard to its history and the character of its work. After discussion, it was voted—That the Secretary be authorized and requested to prepare a short manual of the origin, history, and work of the Academy, to meet this want, and that he be further authorized to associate with himself any other members in co-operation for this purpose.

Rev. Dr. E. P. THWING then spoke on the artistic uses of the trance state, by which fixity of posture and graduated intensity of motion may be created, controlled, and preserved by the photographer, painter, or sculptor. Photographs were exhibited, illustrating the relations of the magnetic state, the supreme condition of voluntary life, to the plastic arts, painting, sculpture, gesture, etc. A greater fixity of condition might thus be obtained for photographic representation than by the usual iron head-rest.

Mr. P. H. DUDLEY then exhibited a series of photomicrographs of wood sections (*Juglans nigra*, *Catalpa speciosa*, etc.), $\frac{93}{100}$ of an inch in diameter, taken by lamplight on eight by ten inch bromo-gelatine plates, with a magnification of about ten thousand diameters.

Mr. G. F. KUNZ presented a cut sapphire gem from Ceylon, whose color was nearly white, but became entirely blue on rotation; a cut zircon from Ceylon, with remarkably high lustre, like that of the diamond, and a weight of over thirty karats; a moonstone, containing a series of hairlike lines (rutile) and rows of fluid-cavities on certain planes, resulting in a strong reflection of light on the cabochon surface; and two lip ornaments from Brazil, the larger consisting of beryl. He also referred to the supposed discovery of diamonds—in one case, 15 karats weight—in Wisconsin, as reported in Western journals. He exhibited gravel from the so-called diamond-mine, but doubted the discovery of the three diamonds said to have been found there.

Mr. J. D. WARNER stated that there had been considerable discussion on the honeycomb. One school of philosophers had constantly pointed out the honeycomb as an evidence of design; inasmuch as it had been mathematically demonstrated that in its construction there was the least amount of waste in material and space, combined with the greatest amount of strength and capacity. Another school had attacked this position with the assertion that

the cell fitted the body of the bee, and that the bee in working was necessarily obliged to plaster up the cell in opposition to the plastering of adjacent cells; so that symmetry was the result, and this gave us the hexagonal system of the honeycomb.

As the cells are merely mechanical receptacles for honey, the idea was suggested that this work might be done by machinery and the time of the bees thus saved for the more legitimate work of collecting the honey. With this in view, the conception of utilizing the old honeycomb was made practical by shaving off the caps of the cells, and then by centrifugal action the honey would be thrown out, leaving the honeycomb to be filled again.

Still, as the old honeycomb was needed for showing the genuine character of the honey, the invention of man reached out to construct the honeycomb for the bee, and succeeded in obtaining the backing and part of the sidewalls of the cells by punching sheets of wax. The first punch was of the form of a cross-section of the cell. This did not serve the purpose, as they were often split at the corners, and a punch of three lines diverging at angles of 120° was used. Such punches, combined in series in a machine, and operated by slightly shifting the rows to and fro, produced a comb foundation, having cells on each side.

The first year more than forty thousand pounds of these foundations were made. The cell walls were one-sixteenth of an inch in height, but enough material was put in the wall to construct the whole height. The bees would commence at the bottom and thin the walls, pushing them outward, and, by continuing this thinning operation, the whole material was utilized. Again, when the cells were made five to the inch, the bees used them for bee-bread; when made six to the inch, the receptacles were used for honey.

The PRESIDENT presented a series of lantern illustrations and described

THE SCENERY OF THE ROCKY MOUNTAIN PARKS.

The Academy then adjourned to the first Monday in October.

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Johnson, Lawrence, M.D. (F.),	323 W. 27th Street.	1880
Judson, Adoniram B., M.D.,	117 E. 17th Street.	1876
Julien, Alexis A., Ph.D. (F.),	School of Mines.	1867
Kelly, William,	9 W. 16th Street.	1876
Kemp, J. F.,	School of Mines.	1885
Ketcham, Mrs. A. C.,	Coleman House.	1884
Kimber, Arthur C., Rev.,	105 E. Houston Street.	1878
King, Clarence, Prof.,	18 Wall Street.	1878
Kirchoff, Chas.,	Cor. Reade and Church Sts.	1882
Krotel, G. F., Rev. Dr.,	49 W. 21st Street.	1877
Kunz, George F. (F.),	Hoboken, N. J.	1876
Lamborn, R. H., M.D.,	47 William Street.	1884
Larremore, R. L., Hon.,	32 E. 60th Street.	1877
Laudy, Louis H., Ph.D. (F.),	School of Mines.	1881
Lawrence, George N. (P.) (F.),	45 E. 21st Street.	1845
Lawton, Walter E.,	12 Cliff Street.	1879
Lecomte, Joseph,	216 Front Street.	1878
Lee, J. Lawrence, M.D.,	21 W. 17th Street.	1868
Leeds, Albert R., Prof. (P.) (F.),	Stevens Inst., Hoboken, N. J.	1872
Levison, W. Goold (F.),	314 Livingston St., B'klyn.	1872
Lewis, Charlton T.,	30 W. 18th Street.	1876
Lewis, W. H., Jr.,	63 W. 19th Street.	1885
Liautard, A., M.D.,	141 W. 54th Street.	1869
Lichtenstein, Paul,	29 William Street.	1876
Livingston, Robert J. (P.),	10 E. 48th Street.	1864
Loewenthal, Herman, M.D.,	239 E. 30th Street.	1877

		ELECTED.
Lord, Benj., M.D.,	34 W. 28th Street.	1885
Lord, Franklin B.,	120 Broadway.	1879
Low, Seth, Hon.,	31 Burling Slip.	1876
Mackie, Simon F. (F.),	Salt Lake City, Utah.	1869
Maclay, W. W.,	709 Madison Avenue.	1877
Marble, Manton,	532 Fifth Avenue.	1878
Marquand, Henry G.,	21 W. 20th Street.	1876
Martin, Daniel S., Prof. (F.),	236 W. 4th Street.	1868
Martin, Edward W.,	47 W. 55th Street.	1882
Mayer, A. M., Prof. (F.),	Stevens Institute, Hoboken.	1872
Maynard, Geo. W., Prof.,	53 Broadway.	1881
McCarty, Edwin R.,	Hotel Brunswick, 5th Ave.	1875
McDonald, John,	11 Pine Street.	1882
McNulty, George W.,	139 Henry Street, B'klyn.	1873
Mead, W. H.,	65 Wall Street.	1882
Mitchell, Edward,	P. O. box 3712.	1876
Moldehnke, E. F., Rev. Dr.,	124 E. 46th Street.	1878
Moore, Gideon E., Ph.D. (F.),	69 Liberty Street.	1876
Morse, J. H.,	43 W. 39th Street.	1881
Mott, Alexander B., M.D.,	62 Madison Avenue.	1867
Mott, Henry A., Jr., Ph.D.,	30 W. 59th Street.	1874
Mulchahey, James, Rev.,	65 Church Street.	1878
Munsell, C. E.,	128 Worth Street.	1885
Neftel, J. W. K., C.E.,	327 W. 42d Street.	1881
Neftel, William B., M.D.,	16 E. 48th Street.	1876
Newberry, John S., Prof., M.D. (P.) (F.),	School of Mines.	1852
Newton, H. J.,	128 W. 43d Street.	1871
Nott, F. J., M.D.,	522 Madison Avenue.	1878
Oothout, E. Austin,	79 Clinton Place.	1882
Otis, Fessenden N., M.D. (F.),	108 W. 34th Street.	1867
Ottendorfer, Oswald, M.D.,	7 E. 17th Street.	1878
Parmly, D. D.,	P. O. box 888.	1879
Parsons, Wm. Barclay, Jr.,	505 Fifth Avenue.	1881
Peabody, Chas. A., Hon.,	60 West 21st Street.	1879
Pearsall, R. F.,	18 Bond Street.	1885

		ELECTED.
Pellew, Chas. E.,	9 E. 35th Street.	1883
Perley, Joseph L.,	23 Dey Street.	1878
Phelps, William W.,	2 Wall Street.	1878
Pitkin, Lucius,	432 Madison Avenue.	1884
Plimpton, Geo. A.,	743 Broadway.	1885
Poggenburg, Justus F.,	153 Broadway.	1885
Potter, Henry C., Rt. Rev. Dr.,	804 Broadway.	1877
Potter, Howard,	61 Wall Street.	1867
Prime, Frederick (O.),	26 Broad Street.	1832
Prime, F. E. (P.),	147 W. 14th Street.	1864
Prime, Temple (P.) (F.),	147 W. 14th Street.	1852
Pyne, Percy R.,	52 Wall Street.	1878
Randolph, John F. (F.),	35 Broadway.	1879
Rees, John K., Prof. (F.),	Columbia College.	1882
Reinhart, Benj. F.,	52 E. 23d Street.	1880
Rice, Charles,	Bellevue Hospital.	1876
Ricketts, Pierre de P., Ph.D. (F.),	School of Mines.	1871
Ripley, John H., M.D.,	605 Lexington Avenue.	1884
Rogers, F. M.,	431 Eighth Avenue.	1877
Rousseau, David,	310 Mott Avenue.	1882
Rudkin, Wm. H. (F.),	74 William Street.	1882
Russell, Wm. H.,	21 W. 10th Street.	1880
Rutherford, Lewis M.,	175 Second Avenue.	1864
Rutter, Thos.,	849 Fifth Avenue.	1880
Salter, Richard P.,	16 Wall Street.	1876
Satterlee, F. Leroy, M.D.,	21 W. 19th Street.	1864
Satterlee, Livingston (O.),	171 Broadway.	1859
Schack, Frederick,	116 E. 61st Street.	1876
Schermerhorn, F. A. (F.),	61 University Place.	1867
Schnetter, J., M.D.,	13 E. 41st Street.	1866
Schoeney, L., M.D. (F.),	670 Lexington Avenue.	1875
Schultz, Carl H.,	76 Union Place.	1878
Schuyler, Philip,	18 Washington Square.	1876
Seeley, Charles A., Prof. (F.),	714 Lexington Avenue.	1867
Serrell, Lemuel W.,	140 Nassau Street.	1876
Shearer, G. L., Rev.,	150 Nassau Street.	1879

		ELECTED.
Shriver, Walter,	333 E. 56th Street.	1878
Sieberg, W. H. J.,	158 E. 124th Street.	1877
Sloan, Samuel (P.),	26 Exchange Place.	1876
Sloane, T. O'Conor, Ph.D.,	119 Pearl Street.	1875
Smith, Mrs. E. A. (F.),	203 Pacific Ave., J. C., N. J.	1878
Smith, J. Tuttle, Rev.,	9 W. 56th Street.	1878
Smith, J. Ward,	Newark, N. J.	1883
Smith, S. Hanbury, M.D.,	309 Broadway.	1876
Snow, E. L.,	115 Broadway.	1882
Spencer, J. Selden, Rev.,	Tarrytown, N. Y.	1880
Stengel, Frederick, Prof.,	416 E. 57th Street.	1876
Stevens, Geo. F.,	33 W. 33d Street.	1882
Stevens, W. Le Conte, Prof.,	Brooklyn, N. Y.	1882
Stevenson, J. J., Prof.,	University of New York.	1880
Steward, D. Jackson (F.) (P.),	150 Fifth Avenue.	1858
Strong, Charles E.,	68 Wall Street.	1878
Stuyvesant, Rutherford,	246 E. 15th Street.	1868
Talbot, Robt. B., M.D.,	102 W. 54th Street.	1884
Talbott, E. H.,	115 Broadway.	1885
Taylor, Charles Fayette, M.D.,	100 W. 53d Street.	1876
Taylor, Henry L., M.D.,	100 W. 53d Street.	1877
Terry, Jas.,	Am. Mus. Nat. Hist.	1883
Thurber, George, M.D. (F.),	751 Broadway.	1867
Todd, A. J.,	261 Broadway.	1878
Tousey, Sinclair,	14 E. 46th Street.	1878
Townshend, John,	Bennett Building.	1882
Tows, C. D.,	P. O. Box 3779.	1878
Trotter, Alfred W.,	112 E. 127th Street.	1875
Trowbridge, W. P., Prof. (F.),	School of Mines.	1878
Valentine, Lawson,	11 E. 17th Street.	1877
Valentini, Philip, Ph.D.,	157 Ninth Avenue.	1882
Van Beuren, Fred. T.,	21 W. 14th Street.	1880
Van Brunt, Cornelius (F.),	319 E. 57th Street.	1876
Van Nostrand, H. D. (P.),	145 Chambers Street.	1850
Van Schaick, Jenkins,	55 S. Washington Square.	1877
Van Slyck, Geo. W.,	120 Broadway.	1878

		ELECTED.
Vaux, Calvert (F.),	Bible House.	1867
Viele, Egbert L., Gen. (F.),	Riverside Ave. and 88th St.	1873
Voorhis, J. H.,	Bethune and Greenwich Sts.	1878
Wall, John L. (F.),	Sixth Avenue & 21st Street.	1879
Waller, Elwyn, Ph.D. (F.),	School of Mines.	1871
Ward, Miss Mary G.,	957 Sixth Avenue.	1881
Ward, Wm.,	52 Broadway.	1880
Warner, James D.,	199 Baltic Street, Brooklyn.	1878
Warner, Alex.,	720 Lexington Avenue.	1882
Weisse, Fanueil D., M.D. (F.),	51 W. 22d Street.	1875
Weld, Mrs. Amy T.,	119 E. 23d Street.	1878
Welch, Uriah,		1879
Wenman, Jas. F.,	146 Pearl Street.	1878
Weston, Edward W.,	339 Wash. St., Newark, N. J.	1877
Weston, Henry (P.),	120 Broadway.	1865
White, Jas. H.,	14 W. 39th Street.	1881
White, Charles T.,	286 Lexington Avenue.	1874
White, Philip A.,	102 Gold Street.	1878
Whitehouse, F. Cope,	Brevoort House.	1884
Whitfield, R. P., Prof. (F.),	Am. Mus. Nat. Hist.	1879
Wiechmann, F. G. (F.),	School of Mines.	1882
Wiener, Joseph, M.D.,	102 E. 61st Street.	1876
Wilber, George M.,	43 Lafayette Place.	1873
Wood, Isaac F.,	Rahway, N. J.	1878
Wurtz, Henry, Prof. (F.),	332 Second Avenue.	1869
Yates, Joseph,	Mott Haven, N. Y.	1879
Youmans, Wm. J., M.D.,	3 Bond Street.	1877

HONORARY MEMBERS.

(RESTRICTED TO FIFTY.)

[Members known to be deceased have an asterisk prefixed to their names.]

*Agassiz, Prof. Louis, Cambridge, Mass.,	1837
Åkerman, Prof. R., Stockholm, Sweden,	1876
*Arnott, G. A. Walker, Arlay, Scotland,	1837
Baird, Prof. Spencer F., Washington, D. C.,	1864
Bentham, G., London, England,	1864
*Bleeker, Prof. P., Netherlands,	1864
Brandt, Prof. J. F., Russia,	1864
Bunsen, Prof. Robert, Heidelberg, Baden,	1876
Candolle, Prof. Alph. de, Geneva, Switzerland,	1852
Carpenter, Prof. W. B., London, England,	1876
Chevreul, Michel Eugéne, Paris, France,	1883
Croll, Prof. James, Edinburgh, Scotland,	1876
Dana, Prof. James D., New Haven, Ct.,	1842
*Darwin, Charles, London, England,	1879
Dawkins, Prof. W. Boyd, Manchester, England,	1876
Dawson, Sir William, Montreal, Canada,	1876
De la Rue, Warren, 73 Portland Place, London, England,	1879
Descloizeaux, Prof. A., Paris, France,	1876
Deshayes, Prof. G. P., Paris, France,	1852
*Deville, Prof. H. St. Clair, Paris, France,	1876
*Dumas, Prof. J. B., Paris, France,	1876
*Egerton, Sir Philip, London, England,	1876
*Ehrenberg, Prof. C. G., Berlin, Prussia,	1864

Fizeau, H. L., Paris, France, 1879
Frankland, Prof. E., London, England, 1879

Geikie, Prof. Archibald, London, England, 1876
Geinitz, Prof. Hans Bruno, Dresden, Saxony, 1876
Gray, Prof. Asa, Cambridge, Mass., 1852
Gruner, Prof. M. L., Paris, France, 1876
*Guyot, Prof. Arnold, Princeton, N. J., 1877

Hall, Prof. James, Albany, N. Y., 1852
Hartlaub, Dr. Gustav, Bremen, Germany, 1864
Hauer, Prof. Franz von, Vienna, Austria, 1864
*Heer, Prof. Oswald, Zurich, Switzerland, 1876
Helmholtz, Prof. H., Berlin, Prussia, 1876
*Henry, Prof. Joseph, Washington, D. C., 1876
Hofmann, Prof. A. W., Berlin, Prussia, 1876
*Holbrook, Prof. John E., Charleston, S. C., 1852
Hooker, Sir Joseph D., London, England, 1879
Huxley, Prof. Th. H., London, England, 1876

Joule, James P., Manchester, England, 1879

Kenngott, Prof. Adolph, Zurich, Switzerland, 1864
Kirchhoff, Prof. Gustavus, Berlin, Prussia, 1879
Kokscharow, Prof. Nicholas von, St. Petersburg, Russia, 1879

Lange, Prof. Victor von, Vienna, Austria, 1876
Lockyer, J. Norman, London, England, 1880
*Lyell, Sir Charles, London, England, 1836

*Martius, Prof. C. F. P. von, Munich, Bavaria, 1841
*Maxwell, Prof. Clerk, Cambridge, England, 1876
*Milne-Edwards, Prof. Henri, Paris, France, 1852
*Murchison, Sir R. I., London, England, 1836

Owen, Prof. Richard, British Museum, London, England, 1879

*Poggendorff, Prof. J. C., Berlin, Prussia, 1876

Quatrefages, Prof. J. L. A., Paris, France, 1879

Rawlinson, Sir Henry Cresswicke, London, England,	1882
Richter, Prof. Th., Freiberg, Saxony,	1876
*Sars, M., Sweden,	1864
*Secchi, Angelo (†S. J.), Rome, Italy,	1876
Siebold, C. T. E., Munich, Bavaria,	1864
Thomson, Sir William, London, England,	1876
Torell, Prof. Otto, Stockholm, Sweden,	1876
Tunner, Prof. P. Ritter von, Leoben, Austria,	1876
*Verneuil, Edward de, Paris, France,	1846
Verreaux, Julius P., Paris, France,	1866
*Wöhler, Prof. Friedrich, Göttingen, Prussia,	1876
Wurtz, Prof. Adolph, Paris, France,	1876
Young, Prof. Charles A., Princeton, N. J.,	1878

CORRESPONDING MEMBERS.

[Members known to be deceased have an asterisk prefixed to their names.]

Abbe, Prof. Cleveland, Washington, D. C.	
Abbott, Dr. Chas. C., Trenton, N. J.,	1883
d'Achiardi, Prof. Antonio, University of Pisa, Italy,	1883
Adams, Rev. H. M., Gaboon, Africa,	1854
Agassiz, Alexander, Cambridge, Mass.,	1866
*Allen, J. A., M.D., Middlebury, Vt.,	1825
*Andrews, Prof. E. B., Marietta, Ohio,	1868
Angas, Geo. French, London, England,	1864
*Anthony, J. G., Cambridge, Mass.,	1852
Appleton, Prof. J. H., Providence, R. I.,	1876
Archbald, Andrew, Paris, France,	1852
Austen, Prof. Peter T., New Brunswick, N. J.,	1878
Ayres, W. O., New Haven, Conn.,	1864
Balch, George T., Saratoga, N. Y.,	1876
Barclay, Robert, England,	1830
Bard, John, Tours, France,	1836
Batchelder, John M., Cambridge, Mass.,	1854
Bayle, Prof. E., School of Mines, Paris, France,	1868
Beadle, E. L., M.D., Poughkeepsie, N. Y.,	1835
Bechler, Lieut. W. H., Newport, R. I.,	1880
Bell, J. Graham, Boston, Mass.,	1878
Bell, James H., Sandusky, Ohio,	1836
Bennet, Rev. Cephas, Tavoy, Birmah,	1847
Berthoud, Edw. L., Golden City, Col.,	1867

Bertrand, Prof. Émile, Rue de Tournon, Paris, France, 1883
*Bigsby, John J., M.D., London, England, 1824
*Billings, E., Montreal, Canada, 1862
Binney, W. G., Burlington, N. J., 1857
Bishop, Nath. H., Lake George, N. Y., 1869
Bodley, Prof. Rachel L., Philadelphia, Pa., 1876
*Boeck, Dr. Wilhelm, Christiania, Norway, 1870
Boissier, E., Geneva, Switzerland, 1852
Bolles, Rev. E. C., Salem, Mass., 1865
Bombicci, Prof. Luigi, University of Bologna, Italy, 1883
*Bradley, Dr. L., Jersey City, N. J., 1871
*Brainerd, Prof. J., Washington, D. C., 1852
Brandegee, Townsend S., Cañon City, Col., 1874
Branner, Prof. John C., Indiana University, Bloomington, Ind., 1884
Brewer, Thomas M., Boston, Mass., 1857
Brewster, Wm., Cambridge, Mass., 1874
*Brinckerhoff, I., M.D., U.S.N., 1828
*Brinckerhoff, P. R., Sing Sing, N. Y., 1839
Brockett, L. P., M.D., Hartford, Conn., 1847
Brown, Rev. Samuel R., S.T.D., Yokohama, Japan, 1859
Brunet, Dr., Bahia, Brazil, 1867
Brush, Prof. Geo. J., New Haven, Conn., 1876
Buck, C. Elton, Wilmington, Del., 1866
*Buckland, Rev. R. J. W., Rochester, N. Y., 1860

Caldwell, Prof. Geo. C., Ithaca, N. Y., 1876
Carmichael, Prof. H., Brunswick, Me., 1876
*Carpenter, P. P., Montreal, Canada, 1864
*Cassin, John, Philadelphia, Pa., 1847
Castelnau, Count, Paris, France, 1839
Chandler, Prof. W. H., Bethlehem, Pa., 1876
Chapman, A. W., M.D., Apalachicola, Florida, 1836
Chapman, Prof. E. J., Toronto, Canada, 1877
*Cheesman, Prof. Louis M., Hartford, Conn., 1884
Chester, Prof. A. H., Clinton, N. Y., 1877
*Chitty, Edward, Jamaica, W. I., 1851
Christy, David, Baltimore, Md., 1852
Clark, Thomas, Bristol, England, 1827
Clarke, Prof. F. W., Washington, D. C., 1876

Clay, Joseph A., Philadelphia, Pa.,	1857
*Coates, Reynell, M.D., Philadelphia, Pa.,	1837
Collett, Prof. John, Indianapolis, Ind.,	1880
Comstock, Prof. Theo. B., Cleveland, Ohio,	1877
*Conrad, Timothy A., Philadelphia, Pa.,	1837
Cook, Prof. G. H., New Brunswick, N. J.,	1874
Cooke, Prof. Josiah P., Jr., Cambridge, Mass.,	1876
Cooke, Dr. M. C., London, England,	1868
*Cooke, Robert L., Bloomfield, N. J.,	1848
Cooper, Dr. James G., Hayward, Cal.,	1855
Cope, Prof. Edward D., Philadelphia, Pa.,	1876
Cornwall, Prof. H. B., Princeton, N. J.,	1876
Cory, Charles B., Boston, Mass.,	1880
*Couthouy, J. P., Boston, Mass.,	1837
Cox, Kenyon, Anaheim, Cal.,	1880
Crawford, Jos. A., Davenport, Iowa,	1877
Credner, Prof. Hermann, Leipsic, Saxony,	1866
Crosse, H., Paris, France,	1864
Dale, T. Nelson, Toronto, Canada,	1879
Dall, William H., Washington, D. C.,	1870
Dana, Prof. Edw. S., New Haven, Conn.,	1885
Deane, Ruthven, Cambridge, Mass.,	1874
*Delafield, Richard, U.S.A.,	1851
*De La Sagra, Raymon, Havana, Cuba,	1835
Denning, W. H., Fishkill, N. Y.,	1832
*Desor, Edward, Neufchatel, Switzerland,	1847
*Diehl, J. S., New Oxford, Pa.,	1867
Divine, Dr. S. R., Lake Sheldrake, N. Y.,	1867
Doubleday, Edward, Epping, England,	1838
Douglass, Prof. Silas H., Ann Arbor, Mich.,	1876
Dow, John M., Panama,	1869
Drown, Prof. Thomas M., Boston, Mass.	1876
Dubois, Henry A., M.D., New Haven, Conn.,	1836
Duns, Prof. John, Edinburgh, Scotland,	1868
Eaton, Prof. Daniel C., New Haven, Conn.,	1860
Edwards, Dr. Arthur M., Newark, N. J.,	1873
Elliot, Daniel G., New York City,	1860

Elliot, Henry W., Washington, D. C.,	1876
Elliott, Prof. John B., Sewanee, Tenn.,	1880
Engelhardt, Francis E., Syracuse, N. Y.,	1869
*Engelmann, George, M.D., St. Louis, Mo.,	1846
Ernst, Dr. Adolfo, Caracas, Venezuela, S. A.,	1878
Fairbank, Rev. W., East Indies,	1853
Fay, H. F., Columbus, Ohio,	1858
Fisher, Geo. Jackson, M.D., Sing Sing, N. Y.,	1845
Fitch, Alexander, Carlisle, N. Y.,	1845
Fittica, Prof. F., University of Marburg, Germany,	1879
Foreman, Dr. E., Washington, D. C.,	1874
Ford, Prof. Darius R., Elmira, N. Y.,	1874
Ford, Silas W., Schodack Landing, N. Y.,	1873
*Foster, J. W., Zanesville, Ohio,	1846
Fresenius, Prof. C. R., Wiesbaden, Germany,	1879
Fritz-Gaertner, Dr. R., Tegucigalpa, Honduras,	1878
*Gabb, Prof. W. M., Philadelphia, Pa.,	1861
Gadolin, Gen. Alex., St. Petersburg, Russia,	1868
*Gale, Dr. L. D., Washington, D. C.,	1826
Gaussoin, E., Baltimore, Md.,	1867
*Gibbes, Prof. Lewis R., Charleston, S. C.,	1847
*Gibbs, George, Washington, D. C.,	1858
Gibbs, Prof. W., Cambridge, Mass.,	1840
Gilbert, G. K., Washington, D. C.,	1870
Gill, Dr. Theodore, Washington, D. C.,	1858
Gilman, Pres. D. C., Baltimore, Md.,	1876
Girard, Charles, Paris, France,	1852
*Giraud, Jacob P., Poughkeepsie, N. Y.,	1840
Goessman, Prof. C. A., Amherst, Mass.,	1865
Goode, Prof. G. Brown, Washington, D. C.,	1876
Gordon, Dr. Antonio de, Havana, Cuba,	1883
*Graham, Thomas, Edinburgh, Scotland,	1829
Grattarola, Prof. Giuseppe, Florence, Italy,	1883
Gravenhorst, J. H. Waters, Bonaire, W. I.,	1882
Green, S. F., Jaffna, Ceylon,	1867
Greenleaf, R. C., Boston, Mass.,	1868
Gregg, Dr. W. H., Elmira, N. Y.,	1865

Gregorio, Marchese Antonio di, Palermo, Sicily, 1883
Grierson, T. M. D., Dumfriesshire, Scotland, 1865
Grote, Prof. Aug. R., Buffalo, N. Y., 1876
Groth, Prof. Paul, University of Strasburg, Germany, 1877
*Guillaudeau, Emile, New Jersey, 1846
Guppy, R. J. L., Trinidad, W. I., 1869

Hagen, Dr. Herman A., Cambridge, Mass., 1874
Hague, James D., San Francisco, Cal., 1874
*Haldeman, Prof. S. S., Chickies, Pa., 1846
*Hallock, Edward J., New York City, 1877
Hamlin, C. E., Waterville, Maine, 1865
Hancock, D., Demerara, W. I., 1824
Hanley, Sylvanus, London, England, 1864
Harden, M. B., Lexington, Va., 1866
Hartman, W. D., M.D., West Chester, Pa., 1852
*Hartt, Prof. C. Fred., Rio Janeiro, Brazil, 1876
Hawkins, B. Waterhouse, London, England, 1868
Hayden, Prof. F. V., Washington, D. C., 1862
Hayes, S. Dana, Boston, Mass., 1876
Henry, Charlton F., U.S.A., 1853
Henwood, W. Jory, Cornwall, England, 1842
Hepburn, J. M., M.D., Japan, 1859
Hesse-Wartegg, Count Ernst von, New York, 1882
Hexamer, Dr. F. M., Newcastle, N. Y., 1857
Hickock, W. C., Vermont, 1848
Hill, Prof. Henry B., Cambridge, Mass., 1876
Himes, Prof. Charles F., Carlisle, Pa., 1876
Hitchcock, Prof. Charles H., Hanover, N. H., 1867
*Holmes, Dr. A. F., Montreal, Canada, 1825
*Hopkins, W., Auburn, N. Y., 1846
Horsford, Prof. E. N., Cambridge, Mass., 1876
Horton, Letas R., Goshen, Orange County, N. Y., 1864
*Hough, Franklin B., M.D., Lowville, N. Y., 1852
*How, Prof. Henry, Windsor, Nova Scotia, 1867
Howard, Thos. T., Jr., Perth Amboy, N. J., 1877
*Hubbard, Dr. E. W., Tottenville, N. Y., 1867
Hunt, Dr. T. Sterry, Montreal, Canada, 1867
Hyatt, Prof. Alpheus, Cambridge, Mass., 1876

Hyatt, Prof. James, Stanfordville, N. Y.,	1876
Iles, Malvern W., Denver, Col.,	1875
Irving, Prof. Roland D., Madison, Wis.,	1874
*Jackson, C. T., M.D., Boston, Mass.,	1834
James, Major O. C., Rio Janeiro, Brazil,	1867
Jamieson, Rev. J. M., Sabatha, India,	1847
Jannetaz, Prof. A., College Sorbonne, Paris, France,	1883
*Jewett, Col. E., Santa Barbara, Cal.,	1867
Johnson, Prof. Saml. W., New Haven, Conn.,	1876
*Johnston, Prof. John, Middletown, Conn.,	1838
Jordan, Pres. David S., Bloomington, Ind.,	1876
Joy, Prof. Charles A., Stockbridge, Mass.,	1878
Judd, Orange, Middletown, Conn.,	1876
Kendrick, Prof. H. L., U.S.M.A., West Point, N. Y.,	1876
*Kerr, Prof. W. C., Raleigh, N. C.,	1869
*King, Alfred T., M.D., Greensburg, Pa.,	1852
King, C. R., M.D., Philadelphia, Pa.,	1838
*King, Henry, M.D., St. Louis, Mo.,	1846
King, Prof. William, Glenoir, Galway, Ireland,	1884
Kinney, Prof. J. R., Honolulu, Sandwich Islands,	1867
*Kirtland, Prof. Jared P., Cleveland, Ohio,	1839
Knowlton, W. J., Boston, Mass.,	1880
Koenig, Prof. Geo A., Philadelphia, Pa.,	1876
Koschkull, H. von, Tiflis, Caucasus,	1868
Krebs, H. J., Copenhagen, Denmark,	1867
Kurtz, J. D., U.S.A.,	1865
Lacerda, Antonio de, Bahia, Brazil,	1867
Land, Wm. J., Atlanta, Ga.,	1877
Langley, Prof. J. W., Ann Arbor, Mich.,	1876
*Lapham, I. W., Milwaukee, Wis.,	1853
Lattimore, Prof. S. A., Rochester, N. Y.,	1876
Lauderdale, J. V., M.D., U.S.A.,	1867
Lea, Isaac, Philadelphia, Pa.,	1829
Lea, M. Carey, Philadelphia, Pa.,	1876
*Le Conte, John L., M.D., Philadelphia, Pa.,	1845
Le Conte, Prof. John, Berkeley, Cal.,	1876

Le Conte, Prof. Joseph, Berkeley, Cal.,	1876
*Lee, Charles A., M.D., Peekskill, N. Y.,	1839
Leidy, Joseph, M.D., Philadelphia, Pa.,	1848
Le Jolis, Dr. Auguste, Cherbourg, France,	1876
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*Lewis, James, M.D., Mohawk, N. Y.,	1864
Lintner, Prof. J. A., Albany, N. Y.,	1872
Lockwood, Rev. S., Freehold, N. J.,	1865
Lord, Henry B., Ithaca, N. Y.,	1868
Lowe, Edward J., Nottingham, England,	1857
Lupton, Prof. N. T., Nashville, Tenn.,	1876
Macfarlane, Dr. James, Syracuse, N. Y.,	1874
Macloskie, Prof. George, Princeton, N. J.,	1876
Mallet, Prof. John W., University of Virginia, Va.,	1876
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Merriam, C. Hart, Locust Grove, Lewis County, N. Y.,	1874
Metcalfe, William, London, England,	1842
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Minot, Dr. Charles S., Boston, Mass.,	1878
Mixter, Prof. Wm. G., New Haven, Conn.,	1876
Moore, Whitby E., Para, Brazil,	1844
Morch, Otto, Copenhagen, Denmark,	1864
*Morris, Rev. John G., Baltimore, Md.,	1864
Morris, W. W., U.S.A.,	1851
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Mortimer, Capt. John H., New York,	1875

Nason, Prof. Henry B., Troy, N. Y., 1876
Nevius, Rev. Reuben D., Baker City, Oregon, 1867
Newcomb, Wesley, M.D., Ithaca, N. Y., 1853
Newton, Alfred, Cambridge, England, 1866
Nichols, Prof. W. Ripley, Boston, Mass., 1876
Nicholls, Dr. H. A. Alford, Dominica, W. I., 1882
Nicolis, Sig. Cav. Enrico, Verona, Italy, 1884
Niles, Prof. Wm. H., Boston, Mass., 1881
Nolan, Dr. E. J., Philadelphia, Pa., 1880
Nordenskjold, Prof. N. A. E., Stockholm, Sweden, 1868

Ober, Frederick A., Beverly, Mass., 1879
*Olmstead, Charles H., Hartford, Conn., 1844
*Olmstead, Rev. Lemuel, Washington, D. C., 1846
Oothout, Henry, Stamford, Conn., 1865
Ordway, Prof. John M., Boston, Mass., 1876
Orton, Prof. Edward, Columbus, Ohio, 1871
*Orton, Prof. James, Vassar College, Poughkeepsie, N. Y., 1870
Ostensacken, Baron R., St. Petersburg, Russia, 1857

Packard, Prof. A. S., Jr., Providence, R. I., 1866
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*Parker, C. H., Camden, N. J., 1865
Parrot, Rev. Dr. J. W., Addison, Steuben County, N. Y., 1869
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Pecchioli, V., Pisa, Italy, 1846
Peck, T. M., Grand Rapids, Mich., 1853
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Pfeiffer, Louis, M.D., Cassel, Germany, 1853
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*Pickering, Charles, M.D., Philadelphia, Pa., 1828
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Pisani, F., 8 Rue Furstenburg, Paris, France, 1883

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Robertson, Rev. J. J., Saugerties, N. Y., 1817
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Roemer, Edward, M.D., Cassel, Germany, 1864
*Roepper, Prof. C. W., Bethlehem, Pa., 1876
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*Stimpson, William, M.D., Chicago, Ill., 1864
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Taber, Augustus, Westchester County, N. Y., 1854
Tajore, The Maharajah Sowindho Mokun, Calcutta, Hindostan, 1885
Taylor, Alexander S., California, 1860
Thomson, James, Paris, France, 1845

Thurston, Prof. Robert H., Ithaca, N. Y., 1876
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*Trudeau, J., M.D., New Orleans, La., 1846
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Tryon, G. W., Jr., Philadelphia, Pa., 1864
*Turnbull, W. P., Philadelphia, Pa., 1865
Tuttle, Prof. D. K., Baltimore, Md., 1876

*Vancleve, John W., Dayton, Ohio, 1852
Van Henrick, Henry, Antwerp, Belgium, 1871
*Vaux, William S., Philadelphia, Pa., 1853
*Verplanck, Gulian C., Fishkill, N. Y., 1817
Verrill, Prof. A. E., New Haven, Conn., 1867
Villa, Antonio, Milan, Italy, 1846
Villa, J. B., Milan, Italy, 1846
Vogdes, Lieut. Anthony W., Governor's Island, N. Y., 1883
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Vollum, Dr. Edw. P., Jefferson Barracks, Mo., 1880
Voss, Lothair, Berliburg, Prussia, 1869

Wailes, B. L. C., Washington, D. C., 1854
Waldo, Leonard, New Haven, Conn., 1876
Walling, Henry F., Boston, Mass., 1869
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Warren, Rev. Joseph, Allahabad, India, 1848
Warring, Prof. Charles B., Poughkeepsie, N. Y., 1876
Weissbach, Prof. A., Bergakademie, Freiberg, Saxony, 1883
Wheatland, Henry, M.D., Salem, Mass., 1858
Wheaton, Dr. J. M., Columbus, Ohio, 1875
White, Rev. G. W., Marietta, Ohio, 1854
White, Prof. I. C., Morgantown, W. Va., 1874
Whittlesey, Charles, Cleveland, Ohio, 1854
Winchell, Prof. Alexander, Ann Arbor, Mich., 1860
Winchell, Prof. N. H., Minneapolis, Minn., 1878
Wissman, J. F., San Francisco, Cal., 1869
*Wood, Rev. Frank A., Beirut, Syria, 1870
Wood, Horatio C., M.D., Philadelphia, Pa., 1866

Woodward, Henry, London, England,	1868
*Woodward, J. J., M.D., Washington, D. C.,	1871
Wormley, Dr. Theodore G., Philadelphia, Pa.,	1874
Worthen, Prof. A. H., Springfield, Ill.,	1867
Wright, Prof. A. A., Oberlin, Ohio,	1874
Wright, Prof. A. W., New Haven, Conn.,	1876
*Wyman, Prof. Jeffries, M.D., Cambridge, Mass.,	1865
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Yarrow, Dr. H. C., Philadelphia, Pa.,	1876

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The Entomological Society of London, London.

The Geological Society, London.
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The Royal Microscopical Society, London.
The Royal Society of London, London.
The Society of Arts, London.
The Zoological Society of London, London.
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The Tynesdale Naturalists' Field Club, Newcastle.

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La Société des Sciences Historiques et Naturelles de l'Yonne, Auxerre.
Commission Metéorologique de la Gironde, Bordeaux.
La Société Linnéenne de Bordeaux, Bordeaux.
La Société des Sciences Physiques et Naturelles de Bordeaux, Bordeaux.
L'Académie Nationale des Sciences, Arts, et Belles-Lettres de Caen, Caen.
La Société Linnéenne de Normandie, Caen.
La Société des Sciences Naturelles de Cherbourg, Cherbourg.
L'Académie Nationale des Sciences, Arts, et Belles-Letters, Dijon.
Union Géographique du Nord de la France, Douai.
L'Académie des Sciences, Belles-Letters, et Arts de Lyon, Lyons.
La Société Linnéenne de Lyon, Lyons.
La Société Nationale d'Agriculture, d'Histoire Naturelle, et d'Arts Utiles de Lyon, Lyons.
La Société d'Histoire Naturelle du Département de la Moselle, Metz.
L'Académie des Sciences et Lettres de Montpellier, Montpellier.
Bulletin de la Société Chimique de Paris, Paris.
Comptes Rendus, Quai des Augustins 55, Paris.
L'École Polytechnique, Paris.
Institut Ethnographique, Paris.
L'Institut de France, Paris.

Journal de Micrographie, Paris.
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Revue et Magasin de Zoologie, Paris.
La Société Américaine de France, Paris.
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Die Geographische Gesellschaft, Greifswald.
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Naturhistorisches Museum zu Hamburg, Hamburg.
Der Naturwissenschaftliche Verein in Hamburg, Hamburg.
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Acta Horti Petropolitani, St. Petersburg.

La Bibliothèque Impériale Publique, St. Petersburg.

Le Comité Géologique, à l'Institut des Mines, St. Petersburg.

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Societas Entomologica Rossica, St. Petersburg.

La Société Physico-Chimique Russe à l'Université de St. Pétersbourg, St. Petersburg.

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Entomologisk Tidskrift, Stockholm.
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Reale Accademia dei Lincei, Rome.
Reale Comitato Geologico d'Italia, Rome.
Osservatorio della Reggia Universitá di Torino, Turin.
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The Nova Scotia Institute of Natural Science, Halifax, N. S.
The Botanical Society of Canada, Kingston, Ont.
Queen's College and University, Kingston, Ont.
The Canadian Entomologist, London, Ont.
The Natural Historical Society of Montreal, Montreal.

The Canadian Record of Science, Montreal.
McGill College and University, Montreal.
The Royal Society of Canada, Montreal.
Geological and Natural History Survey of Canada, Ottawa.
Ottawa Field Naturalists' Club, Ottawa.
The Quebec Literary and Historical Society, Quebec.
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The Entomological Society of Ontario, Toronto, Ont.

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The Boston Society of Natural History, Boston, Mass.
Ornithologist and Oologist, Boston, Mass.
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The Long Island Historical Society, Brooklyn, N. Y.
The Brookville Society of Natural History, Brookville, Ind.
Bowdoin College, Brunswick, Me.
The Buffalo Historical Society, Buffalo, N. Y.
The Buffalo Society of Natural Sciences, Buffalo, N. Y.
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The Astronomical Observatory at Harvard College, Cambridge, Mass.
Harvard University, Cambridge, Mass.
The Museum of Comparative Zoology at Harvard College, Cambridge, Mass.
The Peabody Museum of American Archæology and Ethnology, Cambridge, Mass.

The American Antiquarian and Oriental Journal, Chicago, Ill.
The American Society of Microscopists, Chicago, Ill.
The Chicago Academy of Sciences, Chicago, Ill.
The Cincinnati Society of Natural History, 108 Broadway, Cincinnati, Ohio.
The Ohio Mechanics' Institute, Cincinnati, Ohio.
Hamilton College, Clinton, N. Y.
Ohio State University, Columbus, Ohio.
The Academy of Natural Sciences, Davenport, Iowa.
Des Moines Academy of Science, Des Moines, Iowa.
The American Institute of Mining Engineers, Dr. T. Drown, Easton, Pa.
St. John's College, Fordham, N. Y.
Georgetown College, Georgetown, D. C.
Dartmouth College, Hanover, N. H.
Trinity College, Hartford, Conn.
The Library of Cornell University, Ithaca, N. Y.
The Kansas City Review of Science and Industry, Kansas City, Mo.
The Virginia Military Institute, Lexington, Va.
Washington College, Lexington, Va.
University of Wisconsin, Madison, Wis.
Journal of Mycology, Manhattan, Kan.
The Museum of the Wesleyan University, Middletown, Conn.
The Natural History Society of Wisconsin, Milwaukee, Wis.
The Public Museum, Milwaukee, Wis.
The Geological and Natural History Survey of Minnesota, Minneapolis, Minn.
The Delaware College, Newark, Del.
Geological Survey of New Jersey, New Brunswick, N. J.
Rutgers College, New Brunswick, N. J.
The Connecticut Academy of Arts and Sciences, New Haven, Conn.
Yale College, New Haven, Conn.
The University of Louisiana, New Orleans, La.
The American Chemical Society, N. Y. University, New York.
The American Geographical Society, 11 W. 29th St., New York.
The American Metrological Society, New York.
The American Museum of Natural History, New York.
The Astor Library, New York.

Columbia College, New York.
The College of the City of New York, New York.
Die Aufgeklärten Mosaischen Archi-Geschichte, New York.
The Lenox Library, New York.
The Linnean Society of New York, New York.
The Mercantile Library Association, New York.
The New York Historical Society, 70 Second Ave., New York.
The New York Microscopical Society, 64 Madison Ave., New York.
The School of Mines Quarterly, New York.
State Charities Aid Association, New York.
St. Francis Xavier College, New York.
The Torrey Botanical Club, 9 Waverley Place, New York.
The University of New York, New York.
Illinois State Laboratory of Natural History, Peoria, Ill.
The Portland Natural History Society, Portland, Oregon.
The Academy of Natural Sciences of Philadelphia, Philadelphia, Pa.
The American Naturalist, Philadelphia, Pa.
The American Philosophical Society, Philadelphia, Pa.
The Conchological Section of the Academy of Natural Sciences of Philadelphia, Philadelphia, Pa.
The Zoological Society of Philadelphia, Philadelphia, Pa.
United States Hay Fever Association, Portland, Me.
Vassar Brothers' Institute, Poughkeepsie, N. Y.
The College of New Jersey, Princeton, N. J.
The E. M. Museum of Geology and Archæology, Princeton, N. J.
The Elisha Mitchell Scientific Society, Raleigh, N. C.
The University of Rochester, Rochester, N. Y.
York Institute, Saco, Me.
The American Association for the Advancement of Science, Salem, Mass.
The Essex Institute, Salem, Mass.
The Peabody Academy of Sciences, Salem, Mass.
The California Academy of Sciences, San Francisco, Cal.
The California Farmer and Journal of Useful Sciences, San Francisco, Cal.
Union College, Schenectady, N. Y.
The Academy of Sciences, St. Louis, Mo.
The Library of Syracuse, Syracuse, N. Y.

University of Syracuse, Syracuse, N. Y.
The Natural Science Association of Staten Island, Tompkinsville, N. Y.
The Kansas Academy of Science, Topeka, Kan.
The American Monthly Microscopical Journal, Washington, D. C.
The American Antiquarian Society, Washington, D. C.
The Anthropological Society, Washington, D. C.
Bureau of Ethnology, Washington, D. C.
Congressional Library, Washington, D. C.
The Smithsonian Institution, Washington, D. C.
United States Bureau of Education, Department of the Interior, Washington, D. C.
United States Coast and Geodetic Survey, Washington, D. C.
United States Commission of Fish and Fisheries, Washington, D. C.
The United States Entomological Commission, Department of Agriculture, Washington, D. C.
United States Geological Survey, Washington, D. C.
National Academy of Sciences, Washington, D. C.
The United States National Museum, Washington, D. C.
United States Signal Office, War Department, Washington, D. C.
The United States Military Academy, West Point, N. Y.
The Young Mineralogist and Antiquarian, Wheaton, Ill.
Williams College, Williamstown, Mass.
Rutgers Scientific School, Woodbury, N. J.

ADDENDA.

De Koninklijke Natuurkundige Vereeniging in Nederlandsch-Indië, Batavia, Java.

ERRATA.

Page 62, second line from bottom: for *Elephantum dentalium*, read *Dentalium elephantinum*.
Page 124, sixth line from top: insert * before the name of Prof. M. L. Gruner, deceased.
Page 125, fifth line from top: insert * before the name of Prof. C. T. E. Siebold, deceased.
Page 125, twelfth line from top: insert * before the name of Prof. A. Wurtz, deceased.

CHARTER,

CONSTITUTION,

AND BY-LAWS,

OF THE

NEW YORK ACADEMY OF SCIENCES,

(LATE LYCEUM OF NATURAL HISTORY.)

AN ACT

TO INCORPORATE THE

LYCEUM OF NATURAL HISTORY

IN THE CITY OF NEW YORK.

Passed April 20, 1818.

1. WHEREAS the members of the Lyceum of Natural History have petitioned for an act of incorporation, and the Legislature, impressed with the importance of the study of Natural History, as connected with the wants, the comforts, and the happiness of mankind, and conceiving it their duty to encourage all laudable attempts to promote the progress of science in this State—therefore,

Be it enacted by the People of the State of New York, represented in Senate and Assembly, That Samuel L. Mitchill, Casper W. Eddy, Frederick C. Schaeffer, Nathaniel Paulding, William Cooper, Benjamin P. Kissam, John Torrey, William Cumberland, D. Jurco V. Knevels, James Clements, and James Pierce, and such other persons as now are, and may from time to time become members, shall be, and hereby are constituted a body corporate and politic, by the name of LYCEUM OF NATURAL HISTORY IN THE CITY OF NEW YORK, and that by that name they shall have perpetual succession, and shall be persons capable of suing and being sued, pleading and being impleaded, answering and being answered unto, defending and being defended, in all courts and places whatsoever; and may have a common seal, with power to alter the same from time to time; and shall be capable of purchasing, taking, holding, and enjoying, to them and their successors, any real estate in fee simple or otherwise, and any goods, chattels, and personal estate, and of selling, leasing, or otherwise disposing of the said real or personal estate, or any part thereof, at their will and pleasure: *Provided always*, that the clear annual value or income of such real or personal estate shall not exceed the sum of five thousand dollars: *Provided*, however, that the funds of the said corporation shall be used and appropriated to the promotion of the objects stated in the preamble to this Act, and those only.

2. *And be it further enacted*, That the said Society shall, from time to time, forever hereafter, have power to make, constitute, ordain, and establish such by-laws and regulations as they shall judge proper, for the election of their officers; for prescribing their respective functions, and the mode of discharging the same; for the admission of new members; for the government of the officers and members thereof; for collecting annual contributions from the members towards the funds thereof; for regulating the times and places of meeting of the said Society; for suspending or expelling such members as shall neglect or refuse to comply with the by-laws or regulations, and for the managing or directing the affairs and concerns of the said Society: *Provided* such by-laws and regulations be not repugnant to the Constitution and laws of this State, or of the United States.

3. *And be it further enacted*, That the officers of the said Society shall consist of a President and two Vice-Presidents, a Corresponding Secretary, a Recording Secretary, a Treasurer, and Five Curators, and such other officers as the Society may judge necessary; who shall be annually chosen, and who shall continue in office for one year, or until others be elected in their stead; that if the annual election shall not be held at any of the days for that purpose appointed, it shall be lawful to make such election at any other day; and that five members of the said Society, assembling at the place and time designated for that purpose by any by-law or regulation of the Society, shall constitute a legal meeting thereof.

4. *And be it further enacted*, That Samuel L. Mitchill shall be the President; Casper W. Eddy the First Vice-President; Frederick C. Schaeffer the Second Vice-President; Nathaniel Paulding, Corresponding Secretary; William Cooper, Recording Secretary; Benjamin P. Kissam, Treasurer; and John Torrey, William Cumberland, D. Jurco V. Knevels, James Clements, and James Pierce, Curators; severally to be the first officers of the said corporation, who shall hold their respective offices until the twenty-third day of February next, and until others shall be chosen in their places.

5. *And be it further enacted*, That the present Constitution of the said Association shall, after passing of this Act, continue to be the Constitution thereof; and that no alteration shall be made therein, unless by a vote to that effect of three-fourths of the resident members, and upon the request in writing of one-third of such resident members, and submitted at least one month before any vote shall be taken thereupon.

State of New York, Secretary's Office.

I CERTIFY the preceding to be a true copy of an original Act of the Legislature of this State, on file in this Office.

ARCH'D CAMPBELL,

ALBANY, *April* 29, 1818. Dep. Sec'ry.

ORDER OF

THE SUPREME COURT OF THE STATE OF NEW YORK

TO CHANGE THE NAME

OF

THE LYCEUM OF NATURAL HISTORY IN THE CITY OF NEW YORK

TO

THE NEW YORK ACADEMY OF SCIENCES.

WHEREAS, in pursuance of the vote and proceedings of this Corporation to change the Corporate name thereof from "The Lyceum of Natural History in the City of New York" to "The New York Academy of Sciences," which vote and proceedings appear of record, an application has been made in behalf of said Corporation to the Supreme Court of the State of New York to legalize and authorize such change, according to the statute in such case provided, by Chittenden and Hubbard, acting as the Attorneys of the Corporation, and the said Supreme Court, on the 5th day of January, 1876, made the following order upon such application in the premises, viz. :

At a Special Term of the Supreme Court of the State of New York held at the Chambers thereof, in the County Court House, in the City of New York, the 5th day of January, 1876:

Present—HON. GEORGE C. BARRETT, *Justice.*

In the matter of the Application of the Lyceum of Natural History in the City of New York to authorize it to assume the corporate name of The New York Academy of Sciences.

On reading and filing the petition of the Lyceum of Natural History in the City of New York, duly verified by John S. Newberry, the President and

Chief Officer of said Corporation, to authorize it to assume the Corporate name of The New York Academy of Sciences, duly setting forth the grounds of the said application, and on reading and filing the affidavit of Geo. W. Quackenbush, showing that notice of such application had been duly published for six weeks in the State paper, to wit, *The Albany Evening Journal*, and the affidavit of David S. Owen, showing that notice of such application had also been duly published in the proper newspaper of the County of New York in which County said Corporation has its business office, to wit, in the *Daily Register*, by which it appears to my satisfaction that such notice has been so published, and on reading and filing the affidavits of Robert H. Brownne and J. S. Newberry, thereunto annexed, by which it appears to my satisfaction that the application is made in pursuance of a resolution of the Managers of said Corporation to that end named, and there appearing to me to be no reasonable objection to said Corporation so changing its name, as prayed in said petition: Now, on motion of Grosvenor S. Hubbard, of Counsel for Petitioner, it is:

Ordered, That the Lyceum of Natural History in the City of New York be and is hereby authorized to assume the Corporate name of The New York Academy of Sciences.

Indorsed: Filed January 5, 1876.

A copy. WM. WALSH, *Clerk.*

Resolution of the ACADEMY, *accepting the order of the Court, passed February* 21, 1876.

And whereas, the order hath been published as therein required and all the proceedings necessary to carry out the same have been had, Therefore:

Resolved, That the foregoing order be and the same is hereby accepted and adopted by this Corporation, and that in conformity therewith the Corporate name thereof, from and after the adoption of the vote and resolution herein above referred to, be and the same is hereby declared to be

THE NEW YORK ACADEMY OF SCIENCES.

CONSTITUTION.

ARTICLE I.

This Society shall be styled The New York Academy of Sciences.

ARTICLE II.

It shall consist of four classes of members, namely : resident members, corresponding members, honorary members, and fellows. Resident members shall be such as live in or near the City of New York ; corresponding members, such as reside at a distance from said city ; and honorary members, such as may be judged worthy, from their attainments in science, to be admitted into the Academy. The number of honorary members shall not exceed fifty. Fellows shall be chosen from among the resident members, in virtue of scientific attainments or services.

ARTICLE III.

All fellows and members shall be elected by ballot. The names of candidates shall be proposed in writing, at least two meetings previous to being balloted for. The affirmative votes of three-fourths of the fellows and members present shall be necessary to elect a candidate ; honorary or corresponding members, however, may be elected without previous notice, provided that the ballot on such election is unanimous.

ARTICLE IV.

None but fellows or resident members shall be entitled to vote in the Academy.

ARTICLE V.

No fellow or member who shall be in arrears for one year, shall be entitled to vote, or be eligible to any office in the Academy.

ARTICLE VI.

The officers* of the Academy shall consist of a president, a first and a second vice-president, a corresponding secretary, a recording secretary, a treasurer, five curators, and a librarian, who shall be chosen annually on the fourth Monday of February.† The president, vice-presidents, and secretaries, shall be fellows. There shall also be elected at the same time, a finance committee of three.

ARTICLE VII.

There shall be elected at the annual meeting six members, at least three of whom shall be fellows, who together with the president, the vice-presidents, the two secretaries, and the treasurer, shall constitute a council, by whom all business, to be brought before the Academy, shall ordinarily be prepared. Vacancies occurring in the offices or in the council of the Academy in the interval between the annual elections, may be filled for the unexpired term by special election at any regular business meeting, provided notice of such election shall have been given at a previous regular business meeting.

ARTICLE VIII.

The election of officers and of the council shall be by ballot, and the candidates having the greatest number of votes shall be declared duly elected.

ARTICLE IX.

Five members at an ordinary meeting shall form a quorum, and ten at a special or business meeting, a majority of whom, in either case, shall be fellows.

* See Section 3 of the Charter.

† See sixth line of Section 3 of the Charter.

ARTICLE X.

By-laws, for the further regulation of the society, may from time to time be made.*

ARTICLE XI.

† No alteration shall be made in this Constitution, unless by a vote to that effect of three-fourths of the fellows and three-fourths of the resident members entitled to vote under Article V.

* See Section 2 of the Charter.

† This clause must be taken in connection with Section 5 of the Charter, which requires a previous request in writing of one-third of all the resident members, which must be considered in this case as including fellows, as that class of members was not in existence at the time the Charter was granted, submitted one month previous to any vote being taken.

BY-LAWS.

Chapter I.—*Of Members and Fellows.*

1. No person shall be considered a resident member, until he shall have signed the Constitution and paid his initiation fee; and unless the candidate shall comply with these conditions within six months from the date of his election, such election shall be void. No member in arrears shall be eligible as a fellow.

2. A resident member or fellow removing permanently from the city, may, on giving notice thereof, and on payment of his arrears, become a corresponding member; and a corresponding member who removes to the city, with an intention of making it his permanent residence, may become a resident member, on complying with the provisions of the first section of this chapter.

3. No person not engaged in the pursuit of some branch of science shall be elected a corresponding member.

Chapter II.—*Of Original Subscriptions.*

1. Every holder (whether original subscriber, transferee, or legatee) of a receipt for the sum of one hundred dollars, paid into the treasury of the New York Lyceum of Natural History towards the liquidation of the debt incurred by the erecting of the building formerly the property of the Lyceum, in Broadway, in this city, shall be entitled for himself and his family to free admission to the Museum of the Academy, and to such public lectures as may be delivered on its behalf, which the members have a right to attend. He shall be entitled to the use of the books of the library; and shall have the privilege of introducing strangers to the Museum and library, in accordance with the regulations of the Academy.

Chapter III.—*Of Patrons.*

1. Any person may become a Patron of the Academy of Sciences by contributing, at one time, one hundred dollars toward the fund for the general purposes of the Society.

2. A Patron shall, during his life, be entitled for himself and his immediate family, to the same privileges as an original subscriber.

Chapter IV.—*Of Officers.*

1. The President, or, in his absence, one of the Vice-Presidents, or, in their absence, a Chairman *pro tempore*, shall preside at all meetings of the Academy, and shall have a casting vote. He shall preserve order, and shall decide all parliamentary questions, subject to an appeal to the Society. He shall appoint all committees authorized by the Academy, unless otherwise specially ordered.

2. The Corresponding Secretary shall be charged with the correspondence of the Academy. It shall be his duty to be present at all its meetings, to read all communications made to him in his official capacity; to keep a book in which shall be recorded the correspondence of the Academy, and the names of all corresponding members; to lay the same on the table at all regular meetings thereof; to notify corresponding and honorary members of their election; and to report to the Academy on the fourth Monday of February, annually, the state of its correspondence.

3. The Recording Secretary shall be present at all meetings of the Academy, and keep a record of the proceedings thereof. He shall take charge of all papers and documents belonging to the Society; shall keep a corrected list of members and fellows; shall notify all resident members and fellows of their election, and committees of their appointment; and shall give notice to the Treasurer and to the Council of all matters requiring their action.

4. The Treasurer shall have charge of all moneys belonging to the Academy, and, under its orders, of their investment, and shall give good and satisfactory security to the Society for the faithful discharge of the trust, in a sum not less than five thousand dollars. He shall collect initiation fees and annual dues from all members and fellows, all subscriptions made in behalf of the Academy, and any incomes that may accrue from property belonging to the institution; shall report at the business meeting in January the names of members in arrears; shall give due notice to the Society of the expiration of all policies of insurance that may be effected on its property; and pay all debts against the Society which shall have been audited by the Committee of Finance, or the discharge of which shall have been ordered by the Academy at a regular business meeting. He shall furnish the Committee of Finance, on due application, with such information of the state of the funds as they may require; and shall report to the Academy, at each business meeting, the condition of its finances, and on the fourth Monday of February, the receipts and expenditures of the entire year.

5. The Curators shall be separately charged with the safe-keeping and arrangement of the several collections, and with the keys

of the cabinets. Each Curator shall have his particular department allotted to him when elected. All regulations made by the Curators shall be reported to the Council, and approved of by the Academy, before such regulations shall come into operation.

6. The Curator having charge of any division of the collection, shall alone be authorized to select duplicate specimens from such division for the purpose of exchange or donation ; but no exchange or donation shall be made, except such as is authorized by a vote of the Society.

7. The increase and improvement of the collections being the inducement to exchange, it shall be the duty of the Curators to report to the Society all such opportunities to exchange as would favor this object.

Chapter V.—*Of the Council.*

1. The President, Vice-Presidents, and Secretaries of the Academy, shall hold the same offices in the Council. In the absence of any of them, officers *pro tempore* may be appointed.

2. The Council shall meet at least once a month, within ten days preceding the regular business meeting of the Academy. Minutes shall be kept of its proceedings, which may be called for at any business meeting, upon a vote of the Academy. Matters of a strictly personal nature, however, need not be entered on the minutes of the Council.

3. Five members of the Council, a majority of whom shall be fellows, shall constitute a quorum ; but the Council may appoint an Executive Committee, or business may be transacted at a regularly called meeting of the Council at which less than a quorum is present, subject to the written approval of a majority of the Council, subsequently given to the Secretary, and recorded by him with the minutes.

4. The Council shall prepare all business referred to it by the Academy, and may present any other business at its discretion. It shall frame its own rules and regulations, and determine the time and place of its meetings.

5. The Council shall organize within itself a Committee on Nominations, a Committee on Publication, and a Committee on the Library, to whom, in the intervals of the meetings of the Council, all matters pertaining to these several subjects shall be referred. Their action shall always be subject to the revision of the Council. The names of the persons composing these committees shall be kept publicly posted in the rooms of the Academy.

6. All business prepared by the Council shall be presented to the Academy by the Recording Secretary, or, in his absence, by some other officer of the Council. But the Council may decline to present business at any meeting at which a majority of those present shall not be fellows.

Chapter VI.—*Of Committees.*

1. The Committee of Finance shall audit all accounts against the Academy, and shall have the duties and powers of a Committee of Ways and Means. They shall report on financial questions referred to them, whenever called upon to do so by the Academy or the Council.

2. Committees for Special Purposes may be appointed when required.

Chapter VII.—*Of Sections.*

1. The Academy shall organize itself into sections, as follows:
   I. Biology.
   II. Chemistry and Technology.
   III. Geology and Mineralogy.
   IV. Physics, Astronomy, and Mathematics.

2. These sections shall be organized with at least a Chairman and a Secretary, and shall be considered responsible for the scientific papers to be presented on the first, second, third and fourth Mondays of each month, respectively. When a fifth Monday occurs, it may be devoted to general or special scientific discussions, at the discretion of the Academy or Council. The Academy or the Council may, for sufficient reasons, change or suspend this order.*

Chapter VIII.—*Of Initiation Fees, Annual Dues, &c.*

1. Every resident member, at the time of his admission, shall pay into the treasury, as an initiation fee, the sum of five dollars. All members who become fellows shall pay into the treasury an initiation fee of five dollars. Resident members and fellows shall be subject to pay an annual fee of five dollars.†

2. Any resident member or fellow coming under the provision of Chapter II., or who becomes a Patron, shall be exempt from all future annual dues.

3. The Academy may, on account of services, exempt any member or fellow from his annual dues, provided the proposal be made at a regular business meeting, be approved by the Council, lie over until the next regular business meeting, and all the members then present agree thereto.

4. If any resident member or fellow, in arrears for his annual dues for over one year, shall neglect or refuse to liquidate the

* This method of organization has been suspended, by order of the Academy.

† Corresponding and Honorary members are exempt from initiation fees and annual dues.

same within three months after notification by the Treasurer, his name may be erased from the rolls.*

5. All contributions received under the provisions of Section 2 of this Chapter, as also those received from the Patrons, shall be invested in United States or in New York State securities, and the income derived therefrom be applied to the general purposes of the Academy.

Chapter IX.—*Of the Publications.*

1. The publications of the Academy shall consist of the Annals and the Proceedings, † and such other documents as shall be ordered by the Academy.

2. The publications shall be issued under the supervision of the Committee of Publication, and shall be furnished to members, fellows, and subscribers at such rates as may be determined by the Academy.

3. No member or fellow shall publish any part of the proceedings of the Academy, nor any paper read before it, without the consent of the Council, or by a resolution of the Academy.

Chapter X.—*Of the Publication Fund.*

1. Contributions may be received towards establishing a Publication Fund; all such contributions shall be invested in United States or in New York State securities, and the income thereof be applied toward defraying the expense of the scientific publications of the Academy.

2. Contributors to this fund in the sum of one hundred dollars, or more, at one time, shall be entitled to one copy of all the scientific publications of the Academy appearing subsequently to the date of the payment of their contribution.

Chapter XI.—*Of the Museum.*‡

1. All donations shall have the names of the donors affixed thereto.

2. All members shall have access to the Museum, subject to the regulations of the Academy.

3. All deposited specimens shall be labelled with the name of

* See Section 2 of the Charter.

† This name was changed to *Transactions*, by Resolution of the Academy, December 5, 1881.

‡ This chapter has been suspended, on account of the destruction of the Museum by fire.

the depositor, and while they remain as such, shall be exclusively under the control of the Academy, and subject to the same uses and regulations as the specimens belonging to it.

4. No person, making a deposit of specimens, shall be allowed to remove them without giving a receipt for the same to the Curator in charge.

5. No specimen contained in the Museum shall be loaned, unless by special permission of the Academy.

6. The Curators shall arrange, in systematic order, all the specimens belonging to the Museum, and keep a catalogue of the same; and shall report, on the fourth Monday in February in each year, the state of the property confided to their charge.

Chapter XII.—*Of the Library.*

1. The library shall be under the control of the Librarian and the Library Committee.

2. No book shall be purchased, or other expense incurred for the library, except by a recommendation to that effect signed by a majority of the Library Committee, and ratified by the Council.

3. The Library Committee shall designate such books as ought not to be removed * from the rooms of the Academy, which shall be marked on the catalogue, and shall not be taken out without special permission from the Academy.

4. The Librarian shall be furnished with a book, in which he shall keep a regular account of all books borrowed and returned, by inserting the name of the borrower and the book borrowed, the time when taken out and when returned. In the absence of the Librarian, one of the Library Committee shall keep this record.

5. A volume, not returned within one month, shall incur a fine of fifty cents, and twenty-five cents for each week thereafter.

6. Any injury done to works shall be estimated by the Committee, and the borrower fined accordingly.

7. The Librarian shall report to the Treasurer, from time to time, the fines imposed.

8. No member or fellow shall take out more than two volumes at one time, without special permission from the Council.

9. On the first Monday in June, all books shall be called in; and the Library Committee shall examine the library, and compare it with the catalogue. They shall note all missing books, and report the same, at the next meeting, to the Academy.

Chapter XIII.—*Of Meetings.*

1. The ordinary meetings shall be held on Monday evening in each week.

* By the present rule, no book can be so removed without special permission from the Council.

2. The President, or either of the Vice-Presidents, with any five members or fellows, may call a Special Meeting.

3. Special Meetings shall be called by a notice sent to each resident member and fellow, stating the time at which such meeting is to be held, and the object for which it is called.

4. The meeting held on the fourth Monday in February shall be considered a special business meeting.

5. Ordinary meetings shall be held in such place as shall be determined by the Academy or Council. When meetings are not held in the rooms of the Academy it shall be the duty of the Recording Secretary to notify all the fellows and members of the time and place of meeting. All business meetings shall be held in the rooms of the Academy.

6. Visitors at the meetings shall be introduced by one or more members, and their names shall be announced by the President, and entered on the minutes.

Chapter XIV.—*Of Business.*

1. All business other than such as relates immediately to the cultivation of science, shall be transacted at the first meeting of each month only,—except when the Council shall report it as urgent, in which case it may be transacted at any meeting, provided at least a week's notice shall have been given to all members and fellows.

2. The following shall be considered the regular order of business at the ordinary meetings :—

1. The minutes of the preceding ordinary meeting read, and the sense of the members taken thereon.
2. The names of visitors announced.
3. Signing of the Constitution by new members.
4. Announcement of additions to the Library or Cabinets.
5. Examination of specimens exhibited.
6. Report of Committees not of a business character.
7. Presentation and discussion of papers previously announced.
8. Any other scientific business.
9. Rough minutes read.
10. Adjournment.

3. The following shall be considered the order of business at the regular business meetings :—

1. The minutes of the preceding business meeting read, and the sense of the members taken thereon.
2. The names of visitors announced.
3. Signing of the Constitution by new members.
4. Announcement of additions to the Library or Cabinets.
5. Report of the Council.

6. Reports of Officers.
7. Reports of Committees.
8. Deferred business.
9. New business.
10. Elections.
11. Scientific business.
12. Rough minutes read.
13. Adjournment.

Chapter XV.—*Of Elections.*

1. The annual elections shall be conducted as follows:

Nominations may be sent in writing to the Recording Secretary, with the names of the proposers, at any time not less than thirty days before the Annual Meeting; and the Council shall prepare, from the names so proposed, a list which shall constitute the regular ticket. This list shall be furnished to every resident member and fellow at least two weeks before the Annual Election, and be publicly posted during that time in the rooms of the Academy. But any resident member or fellow shall be at liberty to alter this list, or to prepare another.

The ballots shall be received and examined by at least two tellers, appointed by the presiding officer at the Annual Meeting. A list of the persons who have received the greatest number of votes of those present, certified by the tellers, shall then be presented by them to the presiding officer, who shall thereupon declare the said persons elected to their several offices, and shall present the list to the Recording Secretary, who shall enter it on the minutes and file it: the ballots shall be destroyed as soon as the certified list is handed to the presiding officer.

2. Elections for members and fellows shall be held on the first meeting of each month only. Resident members shall be elected as follows: the candidates shall be proposed publicly, in writing, at any meeting, by a fellow or member; and the nominations, together with the name of the person making them, shall be referred to the Council; the report of the Council shall be openly read at the next regular business meeting, upon which the Academy will proceed to a ballot.* Names of candidates for honorary membership shall be presented by the Council.

3. Fellows shall be elected as follows: candidates shall be recommended to the Council in writing, with the reasons for such recommendation, signed by the proposer; then, if the Council see fit, it shall publicly nominate them at a regular business meeting, and the names of such nominees shall be entered on the minutes, and then be posted in some conspicuous place during all meetings

* See Article 3 of the Constitution.

held in the rooms of the Academy, at least until the next regular business meeting. They shall be balloted for in the same manner as resident members.

Chapter XVI.—*Of General Provisions.*

1. No expenditure shall be incurred on behalf of the Academy, or disbursement made, unless authorized by a vote of a majority of the members and fellows present at a business meeting.

2. No alteration shall be made in these By-Laws, unless such alteration be submitted publicly in writing, at a regular business meeting, be entered on the minutes with the name of the member or fellow proposing the same, and be adopted by two-thirds of the members and two-thirds of the fellows present at a subsequent regular business meeting.

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